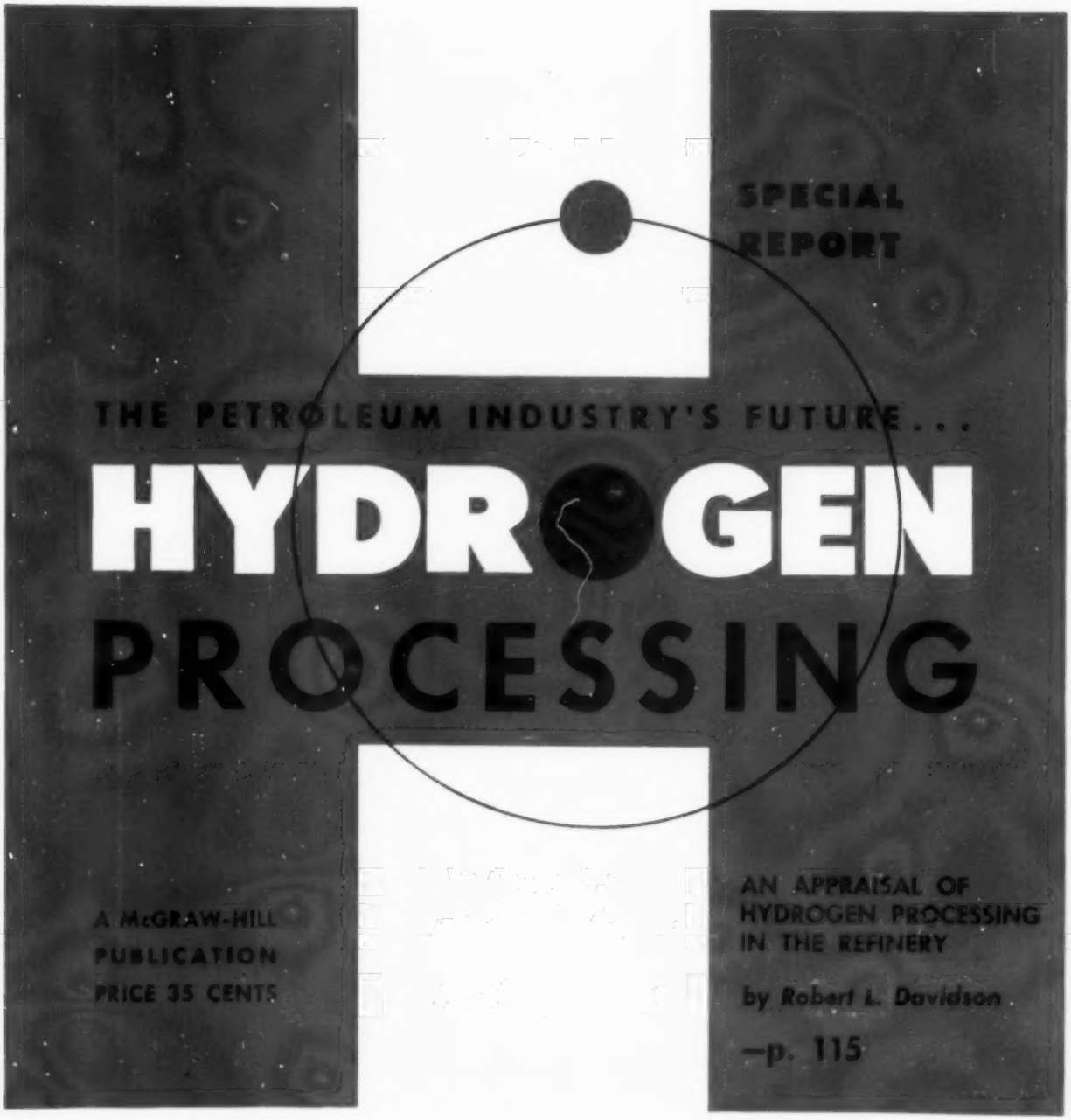
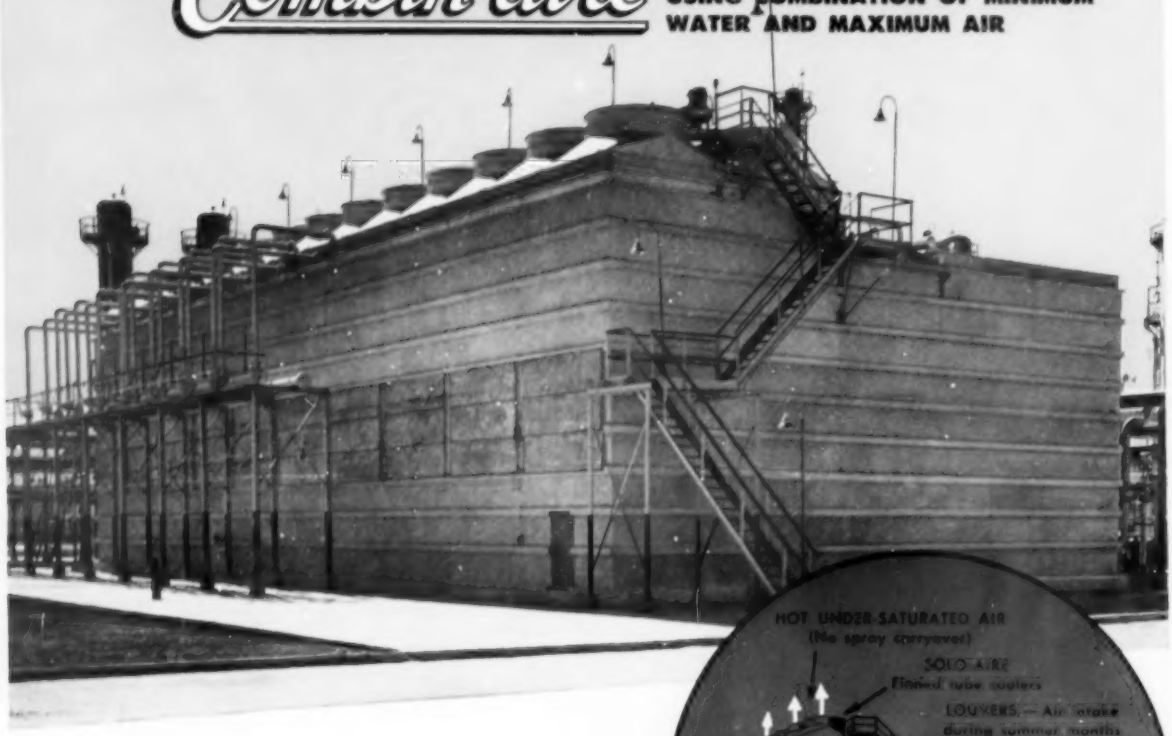
Petroleum Processing

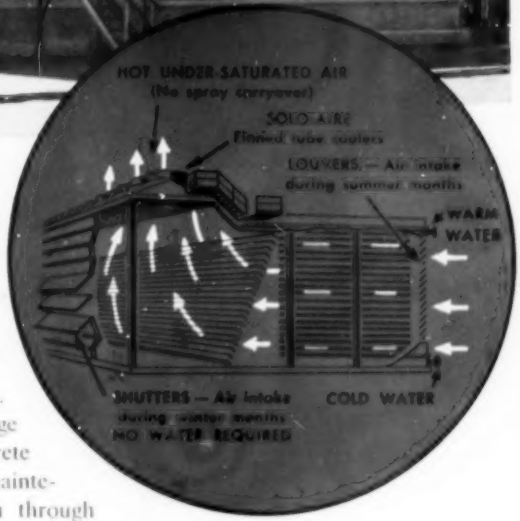
etroleum Refining • Petrochemical Manufacturing • Gas Liquids Recovery NOVEMBER, 1956



HUDSON *Combin-aire*

LOW TEMPERATURE COOLING USING COMBINATION OF MINIMUM WATER AND MAXIMUM AIR





Where quantity or quality of water is low, and ambient air temperatures too high to permit direct cooling with air, process plant designers find the modern solution in Combin-aire. In addition to large savings through minimizing water consumption and eliminating water treatment, Combin-aires incorporate many other advantages.

The Combin-aire pictured above, installed in a large gas processing plant in northern Mexico, is of concrete construction, eliminating fire hazard and minimizing maintenance. As shown in the cut-away drawing, air is drawn through cooled water by fans located on top of the structure. The air, precooled and washed free of solids by the water, flows across the finned tube coolers, and leaves the top of the Combin-aire at elevated temperature under-saturated with water vapor. Mist carryover, condensation from effluent air, and air recirculation are thus eliminated. Combin-aires are installed adjacent to process equipment, minimizing piping and concentrating operating area.

In winter, air flows directly to the Solo-aire finned coolers, water circulation being unnecessary. Where water is required for shell and tube units or atmospheric sections, such water may also be cooled in the Combin-aire unit, eliminating the conventional cooling tower.

In addition to Combin-aire units, Hudson manufactures water cooling towers, air-cooled and water-cooled coolers and condensers, and is experienced in plant layout, piping, and water treatment. We shall be glad to assist prospective plant owners in making overall comparisons of first costs and operating costs for complete cooling systems using various combinations of equipment.

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ENGINEERING CORPORATION

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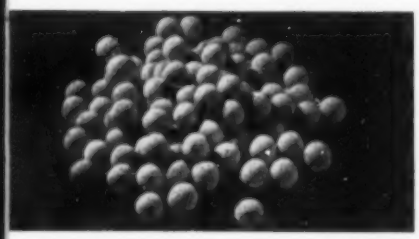
Typical HARSHAW CATALYSTS

and How they are Used

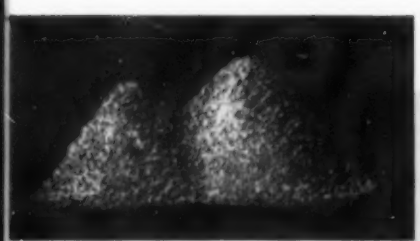
TABLETED

EXTRUDED



SPHERICAL

GRANULAR



POWDERED

Write for FREE booklet,
"HARSHAW CATALYSTS"

DEHYDROGENATION CATALYSTS

CHROME-ALUMINA—available in powder or tablet form containing various percentages of chromium oxide supported on high surface area alumina—can be supplied as promoted catalyst and is also available as screened granules.

IRON—tableted iron oxide.

REFORMING CATALYSTS

MOLYBDENA-ALUMINA—supported molybdenum oxide on alumina—available as microspheres for fluid techniques, or as tablets for fixed bed application.

COBALT MOLYBDATE—a supported cobalt oxide—molybdenum oxide catalyst supplied in tablet form.

NICKEL-ALUMINA—a spherical catalyst available as hard spheres measuring ¼″ to 1″ diameter—used for some types of gas reforming.

DESULFURIZATION CATALYSTS

COBALT MOLYBDATE—a supported cobalt oxide—molybdenum oxide catalyst supplied in tablet form.

ZINC OXIDE—a pelleted zinc catalyst used in the desulfurization of natural gas.

MOLYBDENUM SULFIDE—powdered and tableted molybdenum sulphide.

CHLORINATION CATALYST

COPPER—supported copper catalyst prepared and shipped as tablets or granules.

HYDROGENATION CATALYSTS

NICKEL-KIESELGUHR—supplied as unreduced, or reduced and stabilized, tablets, ⅛″ to ⅜″ diameter.

NICKEL-ALUMINA—available in tablet form containing nickel as nickel oxide on high surface area alumina, or in spherical form supported on low area, high-fired alumina.

RUFERT FLAKES—reduced nickel protected by hardened oil shipped as free-flowing flakes for hydrogenation of all glyceride and acid fats.

COPPER-CHROMIUM OXIDE—shipped as powder or tablets, stabilized or non-stabilized, with varying ratios of copper oxide to chromium oxide.

NICKEL-ALUMINUM—powdered 50:50 alloy used for preparation of active nickel catalyst for low temperature hydrogenation.

CATALYSTS FOR ORGANIC SYNTHESES

ZINC CHROME—a tableted zinc oxide—chromium oxide catalyst used in the synthesis of methanol.

MERCURIC CHLORIDE—a granular catalyst consisting of mercuric chloride on active, granular carbon used in the synthesis of vinyl chloride monomer.

COBALT THORIA—available as powder or tablets, a thoria promoted cobalt catalyst employed in Fischer-Tropsch synthesis.

COBALT—a supported cobalt catalyst in pellet form used in the synthesis of hydrogen sulfide.

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ALUMINA—powdered and tableted aluminum oxide supplied as an active, intermediate surface area catalyst.

Whether your requirement is measured in tons or pounds Harshaw can produce your catalyst exactly to your specifications of raw materials, chemical composition, and physical properties such as length, diameter, crushing strength, abrasion resistance, and bulk density. AND, make delivery when you want it. Call on Harshaw today—for further information or technical assistance.

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Reader's Guide — What's New in Petroleum

I II III 1 2 3 4 5 | I II III 1 2 3 4 5

An EXTRA this Month

HYDROGEN PROCESSING

Special 24-page
PETROLEUM PROCESSING *Report:*

- What it is
- Better process yields
- Better products
- How it works
- Who uses it now
- Future uses
- Processes you can use
- Catalysts you can buy

Hydrogen processing for better process yields and better product quality is rapidly becoming one of the most important processes in the refinery – rivaling catalytic reforming in total capacity.

Here is the first comprehensive "information package" on all aspects of hydrogen processing – desulfurization, denitrification, deoxygenation, olefin saturation, hydrocracking, hydrogen finishing.

The why's and how's of hydrogen processing, as well as detailed descriptions of available processes and catalysts, are included in this report to give you a clear, over-all picture of where we are, and where we are going with hydrogen processing in the refinery.

Turn to p. 115

Cosden's New Rexforming Unit

This first brand new "from-the-ground-up" unit has been making over 100 octane motor fuel in test runs. Here's a full report on the 3870 b/sd installation at the Big Spring, Texas, refinery of Cosden Petroleum Co. p. 79

I 2 3 5

Maleic Anhydride Is Booming

Showing an amazing production rate growth – greater than any other major petrochemical today – maleic anhydride is a product to watch. Peter W. Sherwood tells how it is made and discusses some of its more important uses. p. 82

II 1 2 3 5

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Processing for November, 1956

I II III 1 2 3 4 5

Maintain 15,000 Plug Valves?

That's how many Richfield Oil has to take care of in four natural gasoline and compressor plants in California's San Joaquin Valley. Here's a helpful picture story of how it's being done by means of a handy mobile truck unit. **p. 90**

III 4

All-Concrete Cooling Tower

Well, most of it is concrete. Only the tower packing, mist eliminators, and intake louvers are wood. Petroleos Mexicanos has it at the Reynosa, Mexico, gas process plant, and Southwestern Editor Ron Cannon tells why they like it. **p. 92**

III 2 3 4

Continuous Lube Oil Treating

. . . by acid is a real success. You get lower oil loss, lower maintenance costs, lower acid usage. Here's an up-to-date report on how it is being used in two different installations at two different petroleum processing plants. **p. 95**

I 2 3

The Case of the "Foul" Crime

Sharp technical sleuths solved three "mysteries" in connection with fouling in a feed preparation unit on a catalytic reformer at Ohio Oil by controlling dissolved oxygen in charge stock storage. By J. A. Biehl and W. T. Maddock. **p. 98**

I 3 4

Gasoline Plant Catalytic Reforming

Why Southwest Gas likes its Dubach, La., natural gasoline plant Platformer. One of the first units of this type in the nation, it has been running over eight months producing competitive octanes. By R. F. Cox and R. H. Killgore. **p. 102**

I III 2 3

Planners, Doers, Scorekeepers

You need all three for a successful maintenance program, according to this month's M&C Panelist. E. B. Asmus of Sinclair Refining Co. And in the M&C Problem Corner—a continuation of last issue's query on getting maintenance costs. **p. 108**

I 4

Hydrogen Grows More Important

In addition to the Special Report on Hydrogen Processing this month (see opposite page), the editors have taken a sharp look at the significance of this gas in the world of the future. See the regular department, Tomorrow, on . . . **p. 15**

I II III 1 2 3 4 5

And Watch Future Issues

. . . for important and helpful articles on such subjects as: picking the right metal or alloy for corrosive service, tips on working with insulation for low temperature applications, a look ahead at what 1957 will bring the industry, and many others.

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DEPARTMENTS

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Continue "Readers' Guide" on p. 141

HOW TO USE IT:

Your new "Reader's Guide to What's New in PETROLEUM PROCESSING" will do two things for you. First, the key numbers with each article will tell you at a glance if it is within your scope of interest; Roman Numerals indicate industries; Arabic Numerals, fields of activity. Second, the longer descriptions will tell you what each article is about, and why it can be of help and interest to you. —THE EDITORS

Advertisement

How to make octanes that count

by F. D. BUERSTETTA
Ethyl Corporation, Detroit, Mich.

Manufacture of high-octane gasolines to meet today's and tomorrow's automotive demands is putting increasing pressure on the refiner. Meeting these demands requires that the available hydrocarbon components in the refinery be blended to best advantage to give maximum performance on the road.

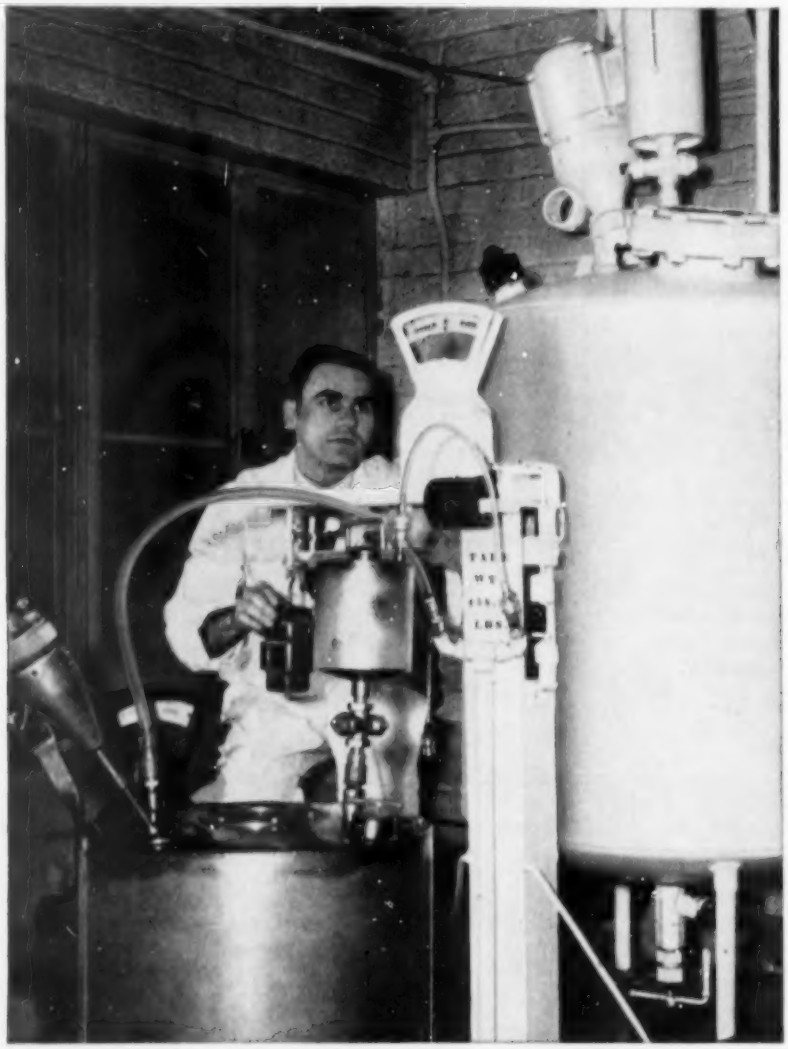
Each octane number at the 100 octane level may cost as much as 15 to 20 cents per barrel. Thus, there is a marked incentive for insuring that each laboratory octane number, obtained at this great expense, provide corresponding antiknock performance in cars on the road.

Hydrocarbon blends studied

As part of a continuing Ethyl Research program to establish the fundamentals of laboratory versus road antiknock quality, a study was conducted not long ago in which the behavior of blends of pure C_7 and C_8 hydrocarbons was examined.

Within this C_7-C_8 range, the four basic hydrocarbon types—olefins, paraffins, naphthenes and aromatics—were blended in varying proportions. Actually, a mixture of iso-octane and *n*-heptane was used as the paraffin constituent to permit maintenance of a constant Research octane number while investigating the effects of tetraethyllead concentration and variations in hydrocarbon-type composition. Toluene, di-isobutylene and methylcyclohexane were selected to represent the aromatics, olefins and naphthenes, respectively. Each of these hydrocarbons was blended in concentrations of 20, 40 and 60 per cent by volume with the proper paraffin mixture, giving nominal Research octane levels of 92, 96 and 100 at each of four tetraethyllead concentrations—0.0, 0.5, 1.5 and 3.0 ml. per gallon.

FIGURE 1. Accurate blending of pure hydrocarbon components at Ethyl Laboratories is the first step in the research program described in these columns.



Each blend was evaluated in laboratory test engines and was then rated in the 9-to-1 compression-ratio engine of a 1955 passenger car equipped with an automatic transmission. Ratings were made by both the Modified Uniontown and Modified Borderline techniques.

The results of that study were reported in detail in "Octane Possibilities with C_7-C_8 Hydrocarbons," copies of which are available on request to Department 33, Ethyl Corporation, 100 Park Ave., New York 17, New York. In general, it was shown that, on the basis of road appreciation (road rating minus Research method rating), highly leaded blends generally outperformed other blends of equivalent R. O. N., especially at high engine speeds.

New data available

Now, a second report in this series entitled "Octanes That Count" is available for your study. This new report compares the various toluene-paraffin blends and di-isobutylene-paraffin blends. Two 1955 passenger cars were used in this study and some interesting data on the effects of vehicle type were obtained.

These cars had V-8 engines of nomi-

 (To obtain more data on advertised products see page 182)

FIGURE 2. A test vehicle on the chassis dynamometer engaged in making one of the hundreds of road octane determinations reported in this Ethyl study.

nal 9.0-to-1 and 8.5-to-1 compression ratios and were selected because these engines represent extremes in fuel-rating characteristics.

In order to bracket the maximum octane-number requirement of the two cars used in the study, the test blends were formulated at three different Research octane number levels. Road ratings obtained at these octane-number levels permitted an estimation of the Research quality of a blend which would just satisfy the antiknock requirements of a vehicle at any engine speed. Comparisons of fuel behavior made in this manner eliminate the possibility of obtaining ratings at overly advanced or retarded spark settings. It is believed that a study of this type provides a realistic appraisal of the relative merits of hydrocarbon type and TEL concentration.

Conclusions

Based on the Research octane number of fuels required to give knock-free operation at various engine speeds under normal conditions, the following generalizations can be made:

1. At high engine speeds (3000 RPM):
   a. Toluene-paraffin blends are superior to di-isobutylene-paraffin blends of equivalent hydrocarbon insert concentration and TEL level in both cars tested.
   b. The Research octane number of fuels required to satisfy either car, regardless of hydrocarbon type and concentration, decreases at higher TEL concentrations.
2. At low engine speeds (1000 RPM):
   a. Toluene-paraffin blends and di-isobutylene-paraffin blends are, in general, equally effective in meeting the vehicles' antiknock requirements. Exceptions are the blends with high concentrations of both TEL and hydrocarbon inserts. For these conditions, the toluene-paraffin blends excelled in one car and were slightly inferior in the other.
3. As the concentration of either toluene or di-isobutylene is increased in blends at any given TEL level, the Research octane number of blends required to satisfy one vehicle increased—and the octane number required to satisfy the other vehicle decreased. Thus, highly paraffinic blends showed superior performance in one car and inferior performance in the other used in this test.

How Ethyl Research can help you

At today's high octane levels, the art of blending hydrocarbons has taken on more and more importance. As a service to the oil industry, Ethyl Research has launched a hydrocarbon blending program of its own to complement the intensive effort which the industry is devoting to this problem.

We are now testing many new blends in our laboratories and in high-compression engines on the road. Much of the data from these tests is being interpreted in terms of "road appreciation" to give refiners a better idea of the effectiveness of each blend. Write Department 33, Ethyl Corporation, 100 Park Ave., New York 17, New York, for a copy of "Octanes That Count"—another in the continuing series of reports from the Ethyl Corporation on fuel blending and other studies of vital interest to refiners today.

For further information, just call your Ethyl Representative. He'll be happy to arrange an appointment for you with one of our Technical Representatives.

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JOHN WIGGINS' ANSWERS TO 8 QUESTIONS CAN HELP YOU SELECT A BETTER FLOATING ROOF SEAL

Are all floating roof seals the same? What about safety? Conservation? We asked John Wiggins, inventor of the floating roof and noted conservation authority, to answer questions most commonly asked about the new Wiggins Safety Seal.

1—**Q.** In the new Wiggins Safety Seal does any of the mechanism contact the liquid?

A. No. All metal working parts are out of the liquid away from corrosive vapors.

2—**Q.** Does the new "Weather Hood" provide longer fabric life?

A. Yes—the fabric is protected from the sun and other elements—lower temperature under the hood provides added conservation.

3—**Q.** In old style seals, rust and scale accumulate and shorten seal life. Does this happen with this seal?

A. The "Weather Hood" prevents rust and scale from depositing in the "seal loop"—thereby increasing seal life.

4—**Q.** Does the Wiggins Safety Seal prevent rim fires?

A. Yes—design of the seal virtually eliminates critical vapor spaces where air and vapor collect to form explosive mixtures. When exploded through controlled tests, the fabric was able to expand enough to contain the explosion without tearing.

5—**Q.** Is this seal safe for the storage of low vapor-pressure, low flash-point liquids such as jet fuels?

A. Yes, the design of the Wiggins Safety Seal reduces the danger area to a minimum so that it can be used in the storage of jet fuels with complete confidence.

6—**Q.** How does the Wiggins Safety Seal guarantee maximum protection against evaporation loss?

A. Air-vapor volume of the Safety Seal is less than 10% of the present volume for floating roof seals. This would eliminate most losses. In addition, the air-vapor space is shielded by a "Weather Hood". This area—the area that breathes—reduces losses to a minimum.

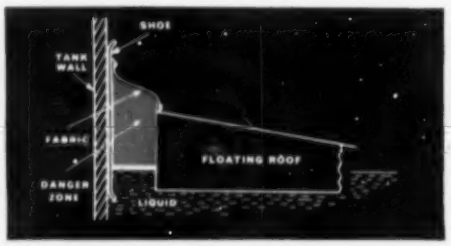
7—**Q.** Will the Wiggins Safety Seal save me money?

A. Yes—by eliminating losses due to thermal breathing, preventing rim fires, use of new longer-lived fabric, protecting the mechanism from liquid and corrosive vapors and permitting much longer periods of "in-service" operation.

8—**Q.** Why have you put so much emphasis on the seal?

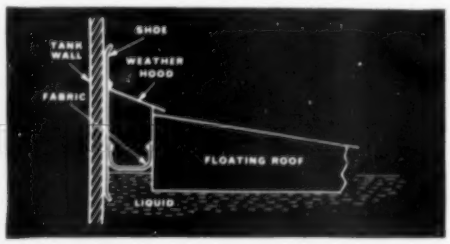
A. A floating roof is only as safe as its seal. With the new Wiggins Safety Seal, Wiggins floating roofs are in a class by themselves. Since General American makes all types of floating roofs, you can have the Wiggins Safety Seal on the roof that best meets your needs—whether it be the Wiggins Hidek* Lodek* or Doubledek*.

*Patented



OLD

With the old type seal, the fabric is exposed to the sun's rays and explosive vapor collects in the large space between the liquid and the fabric; the mechanism is submerged in the liquid and exposed to corrosive vapors.



NEW

With the new Wiggins Safety Seal, vapor space under the circumferential fabric is reduced to a minimum. Ends spark fire hazards. Fabric is protected from the sun. Mechanism is out of liquid and corrosive vapor space.

To see why Wiggins Floating Roofs pay for themselves, write or call your General American sales engineer.

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Publisher's Page

Do You Know the ABC's of ABC?

YOU'VE PROBABLY noticed at one time or another the "ABC" insignia on our Contents pages—in the lower left corner. But do you know what those letters stand for?

They are the initials of the Audit Bureau of Circulation—an organization set up over 40 years ago by a group of publishers to serve as the "watchdog" of the publishing industry. This Bureau audits, and verifies, the circulation that a member publication claims.

Most magazines, including PETROLEUM PROCESSING, publish a circulation statement twice a year. This statement tells how many of you have paid to get each issue of the magazine; it gives detailed figures on such things as what part of the industry you are in, what kinds of jobs you have, where you're located, and how many of you have renewed your subscriptions.

I and my staff are interested in that information—particularly the last point—as a measure of how good a job we're doing. If you don't think the magazine is worthwhile, you won't continue to subscribe—and our renewals will fall off. Our advertisers are interested so they'll know how large and what kind of an audience they are reaching.

Now I'm a trusting sort of guy, and I'll take the circulation department's word for it when it tells me who gets PETROLEUM PROCESSING. But advertisers are a skeptical lot. They've found in the past that some publishers aren't quite as honest as maybe they should be, and that some people a publisher claims as subscribers never saw or even heard of his magazine.

It is the job of ABC to check a publisher's circulation claims and see that they are honest and correct—just as a bank auditor makes sure a bank has all the money it says it has. And ABC auditors are a very thorough bunch. They want the complete name, address, company connection, and job title for every single person we say is a subscriber. A copy of our mailing stencil isn't enough. ABC's auditors want to see the original order you sent in. They want to make sure we haven't upgraded you from foreman to supervisor or plant manager. And they want proof that you or your company actually paid for that subscription—that you aren't merely a name we've added to a list to impress an advertiser.

We have to depend on you, of course, for the information to classify you correctly. If we write you after you've sent in a subscription and ask for more information, it's not because we're nosey. It's because we're doing our part to keep the ABC as a symbol of honest circulation.

William F. Bland

—Editor

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What's Happening

in Refining

. . . **The atom continues to make petroleum industry news:**

- Atlantic Refining Co. has announced the synthesis of octane by the electron bombardment of butanes.
- Continental Oil Co. will study the effect of gamma ray radition on petroleum products and processes in a new $500,000 laboratory at Ponca City, Okla.
- Industrial Reactor Laboratories, Inc. is a new company formed by ten industrial concerns. The purpose is to operate a nuclear reactor for industrial research at Plainsboro, N. J. Participants in the new company are Socony Mobil Oil Co., Inc., Atlas Powder Co., United States Rubber Co., National Distillers Products Corp., Radio Corp., of America, National Lead Co., Corning Glass Works, Continental Can Co., American Tobacco Co., and AMF Atomics, Inc.
- Cook Electric Co., Chicago, Ill., has a 3-year Air Force contract to study the effect of nuclear radiation (colbalt-60) on fuels and lubricants.
- Priviledges to restricted data of the Atomic Energy Commission have been granted to Shell Chemical Co., Shell Development Co., and Sun Oil Co.
- Southwest Research Institute is completing the world's hottest hot lab in preparation for work on gamma ray radiation and its effect on hydrocarbons for Pratt and Whitney, who will equip the lab.

. . . **Shamrock Petroleum Co., Ltd.** will build a 3000 b/d refinery at Haines—Alaska's first.

. . . **Continental Oil Co.** plans to install a 3300 b/d catalytic reformer at its 11,000 b/d, Denver, Colo., refinery. Cost will be $1.4-million, with completion scheduled early 1958.

. . . **El Paso Natural Gas Products Co.** will build a 7000 b/d refinery near Gallup, N. M. Southwestern Engineering Co. will design and construct, with completion due by Oct., 1957. Units will include a Fluid cat cracker, HF alkylation and Platforming.

. . . **Standard Oil Co. (Calif.)** has awarded Fluor Corp. Ltd. the contract to engineer and build a 25,200 b/d stripper to prepare catalytic cracker feed at Standard's El Segundo, Calif., refinery. Completion is scheduled for April 1957.

. . . **American Oil Co.** has started design for a 25,000 b/d atmospheric and vacuum distillation unit for asphalt manufacture at its Yorktown, Va., refinery.

. . . **General Petroleum Corp.** has contracted to have R. M. Parsons Co. build a 12,000 b/d Sovaformer at General's Torrance, Calif., refinery. The cost, including other additions, will be $8-million, with completion expected by Oct., 1957.

. . . **Standard Oil Co. (Ind.)** will have Foster Wheeler Corp. build a 6000 b/d Ultraformer at Standard's Neodesha, Kan., refinery. The unit, together with naphtha desulfurization, is scheduled to be onstream by Jan. 1, 1958.

. . . **Two new hydrocracking processes** were announced at the recent Atlantic City, N. J., meeting of the American Chemical Society (see p. 16, this issue), one by Humble Oil & Refining Co., the other by the Houdry Process Corp.

. . . **Tidewater Oil Co.** has contracted for Catalytic Construction Co. to handle maintenance work on Tidewater's almost completed 130,000 b/d refinery at Delaware City, Del.

. . . **Standard Oil Co. (Ind.)** plans a 2-year, $8-million program to expand research facilities at Whiting, Ind. Included will be a pilot plant building in which experimental plants up to 60 ft high can be built.

. . . **McBride Refining Co.** shut down its 9500 b/d, Brownsville, Tex., refinery for repairs and modernization.

. . . **Bankline Oil Co.** plans to have an Esso Research & Engrg. Co. licensed Fluid Coking unit in operation at its Bakersfield, Calif., refinery by Dec., 1956. Fluor Corp. will build the 4000 b/d unit.

. . . **Great Northern Oil Co.'s** 5200 b/d catalytic hydrodesulfurization unit is now under construction at its Pine Bend, Minn., refinery. The $1-million unit, being built by Fluor Corp. Ltd. will process naphtha feedstock for an Ultraformer. Operation is scheduled for Dec. 1956

. . . **Standard Oil Co. (Ohio)** has placed a $5-million, 11,000 b/d Ultraformer onstream at its No. 1 Refinery, Cleveland, Ohio.

in Gas Liquids Recovery

. . . **Stanolind Oil and Gas Co.** has placed a sulfur recovery unit in operation at its Midland Farms gasoline plant near Odessa, Tex. This is the fourth such unit for gasoline plants operated by Stanolind, the others: Elk Basin, Wyo.; North Cowden, at Odessa, Tex.; and Slaughter, at Sundown, Tex.

. . . **Sinclair Oil & Gas Co. and Skelly Oil Co.** have placed a new gas products plant in operation in the Hulldale field, 12 miles northeast of Eldorado in Schleicher County, Tex. The plant, operated by Sin-

clair, has a gas capacity of 140,000,000 cu ft/month, from which 1,600,000 gal/month of natural gasoline, butane and propane will come.

in Petrochemicals

. . . **Ethyl Corp.** will build an antiknock compounds plant in the San Francisco Bay area. The capacity will be "large enough to serve the growing needs of the West Coast oil industry."

. . . **Imperial Oil Ltd.** has announced contractors for its new petrochemical complex at Sarnia, Ont. (see PETROLEUM PROCESSING, March, 1956, p. 10 and Aug., 1956, p. 9). Fluor Corp. of Canada, Ltd. will build the alkylate plant, and Canadian Bechtel, Ltd. will build the primary petrochemicals plant.

. . . **Spencer Chemical Co.** will build a "modest sized" plant to produce nylon molding resin at its Henderson, Ky., works. Completion is due in mid-57.

. . . **Ashland Oil & Refining Co.** will add facilities at its Buffalo, N. Y., refinery to produce 21-million gal/yr of benzene, toluene, xylene and other petrochemicals. Onstream is scheduled for late-57.

. . . **Lord Mfg. Co.** of Erie, Pa., has announced a "high-frequency electrical discharge process" for otherwise difficult gas-phase reactions. It has already been tested for making anhydrous hydrazine from ammonia with good yields claimed.

. . . **American Synthetic Rubber Co.** has contracted for Walter Kidde Constructors, Inc. to design, engineer, and build a $3-million addition to American's Louisville, Ky., synthetic rubber plant. Completion is scheduled for Jan., 1957.

. . . **Dow Chemical Co.** has purchased a Burrough's E102 electronic, digital computer for use in the Process Design Section at Dow's Freeport, Tex., plant.

. . . **Diamond Alkali Co.** plans a "multimillion-dollar" acetylene-from-natural gas unit at its Deer Park (near Houston), Tex., plant. Construction will begin in late '57.

. . . **Reichhold Chemicals, Inc.** has made a new approach to petrochemicals through long term contracts with Escambia Chemical Corp. A new joint facility to produce methanol, near Pensacola, Fla., is scheduled for startup in early-58.

. . . **Pitt-Consol Chemical Co.** (subsidiary of Pittsburgh Consolidated Coal Co.) has entered the petrochemical field through two new avenues:

- At Newark, N. J., Pitt is building a $3.5-million plant to produce cresylic acids, cresols and phenols from refinery wastes in the area by Jan., 1957.
- Pitt has joined with Standard Oil Co. (Ohio) to form a new company named Mountaineer Carbon Co., which will operate a 165,000 t/yr carbon calcining plant at Cresap, W. Va., producing electrode carbon. Part of the feed carbon will be from coal, the remainder will come from Sohio as petroleum coke. Operation is scheduled by Jan., 1958.

in Transition

. . . **Panhandle Oil Corp.** stockholders have officially approved merger into American Petrofina, Inc. (see PETROLEUM PROCESSING, Mar., 1956, p. 12; July, 1956, p. 10; Aug., 1956, p. 10). American Petrofina, Inc. will be the surviving company.

. . . **Cosden Petroleum Corp.** is getting 16,000 b/d more refining capacity through the purchase of Onyx Refining Co., Abilene, Tex. (6,000 b/d), and Col-Tex Refining Co., Colorado City, Tex. (10,000 b/d).

in Foreign Operations

. . . **Britain and Europe:**

Petrochemicals Ltd. (Shell Chemical Co. associate) will build a $4.9-million styrene monomer plant at Partington, England. Completion is due in 1958.

Ruhrbau G.m.b.H. of Mulheim, Germany, plans to build a 50,000 b/d refinery at Duisburg. The plant is to be onstream by the end of 1958.

Shell Petroleum Co. will install an 80,000 b/d crude still in its Shell Haven refinery in the Thames estuary. The new unit will be completed by the end of 1958 and will cost $18.2-million.

British Hydrocarbon Chemicals Ltd. will build a 25-million lb/yr polyethylene plant at Grangemouth, Scotland, using the Phillips Petroleum Co. polyethylene process.

Esso Petroleum will build a 100,000 b/d refinery in the Milford Haven area of South Wales. The project will cost about $50-million.

Farbenfabriken Bayer, AG, has contracted with Scientific Design Co., Inc. for a license to build a 26,000,000 lb/yr ethylene oxide plant at Leverkusen, Germany. Operation is scheduled for 1957.

Monsanto Chemicals Ltd. will erect a 10,000 t/yr polyethylene unit at Fawley, England, scheduled for completion in 1958. Following this unit will be facilities to copolymerize monomers such as acrylonitrile and butadiene. Monsanto will then build an acrylonitrile plant. Total cost, $23.8-million.

A jointly owned polyvinyl acetate plant will be erected at Flix, Spain, by Farbwerke Hoechst (Germany) and Electro-Química de Flix (Barcelona), to produce 1400 t/yr. Units for acetaldehyde, acetic acid and anhydride will also be installed. Production is to start early-57.

. . . **Hajduki Chemical Coke Co.** of Poland is planning a new phenol plant to be engineered by West

Danger... Corrosion at work!

ABOUT THIS PHOTOGRAPH— In capturing this closeup of corroded "coupons" and a distance shot of a refinery on the same negative, well-known photographer Bernard Hoffman achieved amazing depth of focus. Using revolutionary techniques which he has pioneered, Mr. Hoffman is able to achieve over-all sharpness of near and far objects; long the goal of photographers.

Internal refinery corrosion, as measured by these badly corroded coupons, is becoming a thing of the past where Polyrad inhibitor is used. Because Polyrad is a filming amine, it forms a molecular film that protects metal from attack. And Polyrad's detergent action aids in keeping the metal surfaces clean, thereby maintaining heat transfer and operation at unit capacity.

Polyrad is available from stocks maintained throughout the country. We'll be glad to tell you how to protect your refinery with Polyrad.

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German technicians and installed by East German and Polish workers.

. . . Latin America

Petróleos Mexicanos will have started building a 1000 b/d naphthenic-based lube plant at Minatitlán, Mexico, and is planning a grease plant at Salamanca. Both units are to be completed in 1958. Fluor Corp. Ltd. has the contract for the $4.5-million lube plant. Plans for the grease unit are not firm, except that its initial capacity will be 25 t/day.

Petróleo Brasileiro, S.A., plans to build a 90,000 b/d refinery in the Rio de Janeiro, Brazil, area. The company has called for U.S. companies to submit information on refinery construction and design experience. Bids will be called for later.

Rilsón Brasileira S.A. has received a $1.3-million loan from Credit Lyonaise of Paris to build a new nylon plant near São Paulo, Brazil.

Brazil's government-owned mineral oil concern, Petrobas, has contracted with Edeleanu GmbH of Frankfort, Germany, to build a sulfur dioxide extraction plant for kerosine and gasoline. Location will be at the Presidente Bernardos refinery, Cubatão.

Argentine government officials have announced that the government will leave petrochemical developments to private capital (local and foreign) in Argentina.

Creole Petroleum Corp. expects to let a contract in Dec. for a fourth pipe still at Amuay, Venezuela, and is planning a lube plant. The Amuay expansion program is said to call to a refinery capacity of 500,000 b/d by 1960—second only to Iran's Abadan refinery.

. . . the East

Montecatini and An-Saldo (Italian firms) plan to build a $35.7-million nitrogenous fertilizer plant at Multan, western Pakistan, to produce 100,000 t/yr. The U.S. is helping with a $200,000 advance

British Petroleum Co. Ltd.'s refinery at Kwinana, Australia, will have a $9-million expansion program, to include a catalytic reformer.

A Jordan government mission plans to visit Syria, Lebanon, Egypt, Saudi Arabia and Kuwait to seek Arab private capital to build a refinery in Jordan.

The Ceylon government has received an offer from an American oil company to build a refinery in Ceylon. A previous offer by Anglo-American oil interests in Ceylon (Shell, British Petroleum, Standard-Vacuum and Caltex) was rejected as too monopolistic. These companies have been asked to make a new offer.

Iraq plans to go ahead with its long-standing plans to use its oil field natural gas output to produce fertilizers, cement, and other byproducts. $98-million has been allocated for a 5-year program to erect plants at Kirkuk, Basrah and Masul.

J. M. Huber Corp. will design Australia's first carbon black plant, to be erected near Melbourne as a joint project of United Carbon Co., Inc. of the U.S. and Shell Co. of Australia Ltd.

Idemitsu Kosan Co. Ltd. has received Japanese government approval for a technical assistence contract with Universal Oil Products Co. to use the Unisol gasoline treating process. The unit will be at Idemitsu's Tokuyama refinery, and will handle 3000 b/d straight-run gasoline and 1000 b/d jet fuel.

in Markets and Prices

. . . Distillate market rapidly gained strength last month. Prices moved up at the Gulf, Eastern Seaboard, and in the Midwest, and there was talk of higher prices in the Mid-Continent.

Increases of 0.375¢ on kerosine and 0.2¢ on No. 2 fuel and diesel oils at the Gulf, coupled with firm tanker market, prompted East Coast price hikes. Wholesale price schedules generally were up 0.4¢ on kerosine, 0.3¢ on No. 2 fuel and shore plant diesel. Marine diesel medium fuel for shipping trade also ranged 8¢ to 13¢/bbl higher in the East, while heavy marine diesel quotations advanced 10¢/ bbl.

One feature of the increase was the apparent change in thinking on value of kerosine. Price differential between this product and No. 2 fuel, which had dropped in recent years from 1¢ to 0.5¢/bbl, went up to 0.6¢. Spread also widened at the Gulf. In the Midwest one marketer who advanced distillate prices raised his differential between kerosine and No. 2 fuel from 0.75¢ to 1¢/gal.

. . . Gasoline picture was different. Despite sharp cutbacks in refinery runs, top-heavy inventories sent prices down as much as 0.5¢/gal in the Midwest and 0.25¢/gal in the Mid-Continent. Cargo quotations at the Gulf also were shaky.

. . . Heavy fuels held firm in most primary districts, and consensus is that supplies may be tight this winter. On West Coast, situation already is acute. Some refiners are ready buyers while others are allocating supplies to regular customers.

Looking Ahead

. . . Three synthetic rubbers, one old, two new, are bouncing into the limelight:

- All-butyl rubber tires will be test marketed soon. Developed by Esso Research & Engineering Co. and Armstrong Tire Co. (see p. 15, this issue), the success of these tires could mean a whole new round of butyl rubber plant construction.
- Coral rubber, a newly developed polyisoprene with the essential properties of natural rubber, made by Firestone Tire & Rubber Co. has successfully passed Army Ordnance Corps military-truck-tire tests. Hitherto, natural rubber had been used because of its superior heat resistance.
- Ameripol SN, another new synthetic duplicate of natural rubber, developed by Goodrich-Gulf has been reported to be superior to natural in military tires.

16 complete refineries

1945

1. Refinery for B. P. M. at Cardon, Venezuela.
2. Refinery for Koppartrans Oljeaktiebolag at Gothenburg, Sweden.
3. Refinery for Venezuela Gulf Refining Company at Puerto La Cruz, Venezuela.
4. Refinery for Societe Generale des Huiles de Petrole at Dunkirk, France.
5. "Portable" refinery for U. S. Navy Department.
6. Lube oil refinery for Cit-Con Oil Corporation at Lake Charles, Louisiana.
7. Refinery for International Refineries Inc. at Wrenshall, Minnesota.
8. Refinery for Vacuum Oil Company Ltd. at Coryton, England.
9. Refinery for Burmah-Shell Oil Company at Bombay, India.
10. Refinery for Standard-Vacuum Oil Company at Bombay, India.
11. Refinery for Standard Oil Company (Indiana) at Mandan, North Dakota.
12. Refinery for Suntide Refining Company at Corpus Christi, Texas.
13. Refinery for Commonwealth Refining Company at Ponce, Puerto Rico.
14. Refinery for Esso Standard Oil Company at Antwerp, Belgium.
15. Refinery for Caltex at Visakhapatnam, India.
16. Refinery for Neste Oy at Turku, Finland.

1955

In the past 10 years alone, Lummus has completed or is currently working on 16 complete refineries. Combined, they represent a large percentage of the refinery capacity constructed in the last decade.

But complete refineries are only part of the Lummus story. Separate units for any and all phases of refining from distillation to petrochemical production have been designed, engineered and built by Lummus – as additions to existing installations or as integral parts of new construction.

In the past 50 years, Lummus has added over 700 petroleum and chemical plants and installations to the world's total. Think of Lummus when planning your next project.

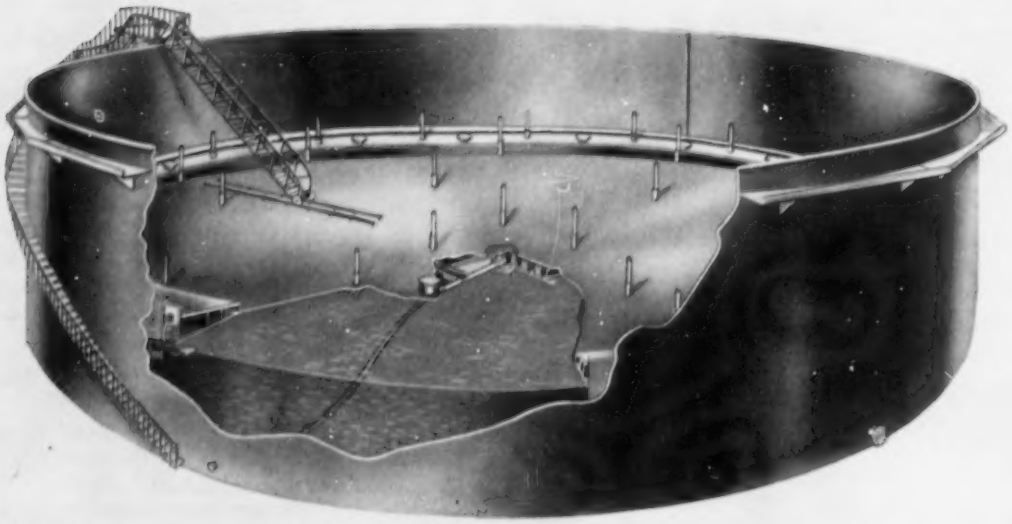
THE LUMMUS COMPANY, 385 Madison Avenue, New York 17, N. Y. *Engineering & Sales Offices:* New York, Houston, Montreal, London, Paris, The Hague, Bombay. *Sales Offices:* Chicago, Caracas. *Heat Exchanger Plant:* Honesdale, Pa. *Fabricated Piping Plant:* East Chicago, Indiana.

LUMMUS

ENGINEERS AND CONSTRUCTORS FOR INDUSTRY

GRAVER

WE'VE CLEARED THE DECK...



STABLE . . . because, ship-like, the center of buoyancy is below the center of gravity.

CORROSION-RESISTANT . . . because the liquid in storage is in full contact with the deck.

SELF-DRAINING . . . rainfall flows to the Graver sump at the center low point of the roof.

VAPOR-STOP SEAL . . . Graver's patented single seal . . . proved effective against vapor loss.

. . . FOR A NEW, LOW-COST FLOATING ROOF TANK WITH UNDER-DECK CENTER WEIGHT

Here is another outstanding Graver first in single-deck floating roof tanks. We've cleared the deck for easy snow removal and positive drainage by putting the center weight *below* the deck. This effects additional economies in construction without sacrificing the long-established advantages of Graver's patented single-deck floating roof principle and characteristic Graver quality. This new Graver floating roof tank (both pontoon and pan type) has been thoroughly proved by installations across the nation. May we give you complete details?

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EAST CHICAGO, INDIANA • NEW YORK • PHILADELPHIA • EDGE MOOR, DELAWARE
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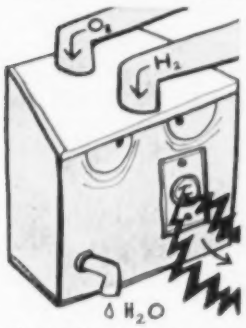
HOUSTON • LOS ANGELES • FONTANA, CALIFORNIA • SAN FRANCISCO

Chalk Up Another Potential Use For Hydrogen—Electric Power

THE many uses for excess hydrogen in refineries (see Special Report in this issue, beginning on p. 115) may soon welcome a newcomer if present research can come up with the right answer. The device: a fuel cell that uses gases instead of metals to create electrical power.

Ever since Englishman Sir William Grove produced the first experimental fuel cell in 1839, the search has been on to develop a unit that can compete economically with today's storage battery. The most recent work reported in this country is being carried on at National Carbon's research center, where a fuel cell is producing electricity from the reaction of hydrogen and oxygen.



How does the fuel cell differ from the conventional storage cell? The latter produces free electrons (electricity) by chemical reaction between an electrolyte and metal electrodes. Completing a circuit between the two immersed electrodes permits the freed electrons to flow between them. The "fuel" in this type of storage cell—for example, the common flashlight battery—is a zinc electrode, which is gradually consumed.

In a gaseous fuel cell, however, it's possible to "burn" hydrogen in an electrochemical reaction that produces H_2O and free electrons. The process might be considered reverse hydrolysis.

In a flashlight battery the two electrode materials (zinc and manganese dioxide) are both relatively good conductors. However, it has been found that an "air electrode," using oxygen direct from the atmosphere, can replace MnO_2 as the oxidizing electrode.

But because oxygen is a non-conductor, it's necessary to "adsorb" it on the surface of an electrical conductor. In National Carbon Co.'s fuel cell the oxygen carrier and conductor is, quite naturally, activated carbon.

Some problems must still be solved before the refiner can consider gaseous fuel cells a practical source of secondary power. At present the 40% efficiency of the fuel cell does not approach the 75% efficiency of the typical lead cell. And the porous carbon wafers must be improved for long life. However, the fuel cell does have advantages. It's lighter per kilowatt produced, and can run as long as oxygen and hydrogen gases are available to flow through it.

The first use of a successfully developed fuel cell will probably be as a stand-by or peak-load reserve of electricity. Later, the refiner will probably be able to convert excess hydrogen directly into power. Instead of burning normal fuels and going through a heat engine (steam turbine and generator) before electric power is created, it may be possible to feed hydrogen—or even natural gas—directly into a fuel cell and produce power.

Already, two American patents have been issued to Pittsburgh Consolidated Coal Co. for doing this with coal gases. And a small prototype that creates 2-3 kw of power has been built in England. —W.A.B.

Butyl Rubber Outlook Changes With Advent of Use in Tires

BUTYL rubber, mainstay for "air-holding" innertubes, seemed to face a bleak future when the new tubeless tires rolled in. Now the tires themselves might be made of butyl rubber.

Esso Research & Engineering Co. has just announced successful butyl tire manufacture under pilot-plant conditions at the Armstrong Tire Co. plant at West Haven, Conn. Several hundred of these new tires have been distributed to automobile manufacturers for testing.

Striking physical properties are shown by the new butyl tires. They are said to stop 30% faster than GR-S and natural rubber tires on wet pavement, 20% faster on dry pavement. There is more shock-absorption in the butyl tire, giving a smoother ride.

The butyl tire resists ozone attack (because it is more saturated) and acids, but is about average in oil resistance. The noise level of the butyl tires is about 15 decibels lower than GR-S and natural, and there is no high-pitched squeal on rounding corners.

Butyl rubber is a product of the polymerization of isobutylene and isoprene at —140°F. It was discovered in 1937 by W. J. Sparks and R. M. Thomas of Esso Research & Engineering Co.;

however, drawbacks in the original butyl rubber, and the cheapness of natural rubber, kept butyl from being exploited until World War II.

Government fears of being cut off from far-eastern rubber supplies spurred new research on butyl rubber. This resulted in two large butyl rubber plants—Baton Rouge, La., and Bayway, Tex.

Following the war, the two government-owned plants were sold, Baton Rouge to Esso Standard Oil, and Bayway to Humble Oil & Refining Co. These two plants have a combined capacity of about 116,000 long tons/yr and are the only butyl plants in the U. S.

If the demand for rubber reaches the estimated 2-million t/yr in 1960 (compared to about 1.75-million in 1955) there could be a great increase in demand for butyl rubber, and a growth in production facilities. —R.L.D.

Will Free Piston-Turbine Engine Be Automotive Power Source?

AUTOMOTIVE engineers are excited over a new type of power plant consisting of a high speed, free-piston gas generator combined with a gas turbine. Some believe it offers more possibilities for passenger car application that does direct fuel injection or the adaptation of some form of the diesel engine.

General Motors Research staff has reported to the Society of Automotive Engineers on experiments with a 250 hp free-piston gasifier plus turbine engine installed in a passenger car. The gasifier, basically a uniflow, two-cycle diesel engine, feeds the gases it discharges into the turbine at a temperature several hundred degrees cooler than the gases from the burner of a comparable conventional gas turbine power plant.

Fuels can be kerosine, diesel fuel, or Bunker C oil, with sulfur content up to 4%, but with high cetane number for good starting and idling. Oil men say refinery operations might have to be radically altered to produce high cetane fuels if large volumes were required. —V.B.G.

Is Hydrocracking of Residual Fractions About to Come of Age?

HYDROCRACKING of heavy petroleum fractions to make lighter products is coming closer to economic feasibility according to papers presented at the American Chemical Society's Division of Petroleum Chemistry meeting at Atlantic City, N. J., Sept. 17-21.

Hydrocracking, the combined cracking and hydrogenation of hydrocarbons, is not a new art as such (see Special Report on "Hydrogen Processing," pp. 115-138, this issue). However, the need for high pressures, large amounts of hydrogen, and short catalyst life have kept hydrocracking from becoming commercially active in the U. S.

Houdry Process Corp.'s Heinemann and Stevenson report a novel hydrocracking approach wherein coke formation, and resulting catalyst deactivation, are almost eliminated by diluting the heavy residue to be hydrocracked with a light hydrocarbon, such as butane. Onstream catalyst life of well over 300 hours was obtained, as compared to only 20-30 hours with no diluent.

Investment costs for the Houdry hydrocracking are still high by industry standards, estimated at $500-800/bbl, with operating costs of around 30-35¢/bbl (assuming fuel at $2.75/bbl and excluding the cost of hydrogen).

The pressures are still high, around 3500 psig, for this process, but a standard cobalt molybdate on alumina catalyst can be used. Yields of gasoline (low in octane, but susceptible to catalytic reforming) are kept low, with the primary product being a material in the gas oil range which can be used as catalytic cracker feed.

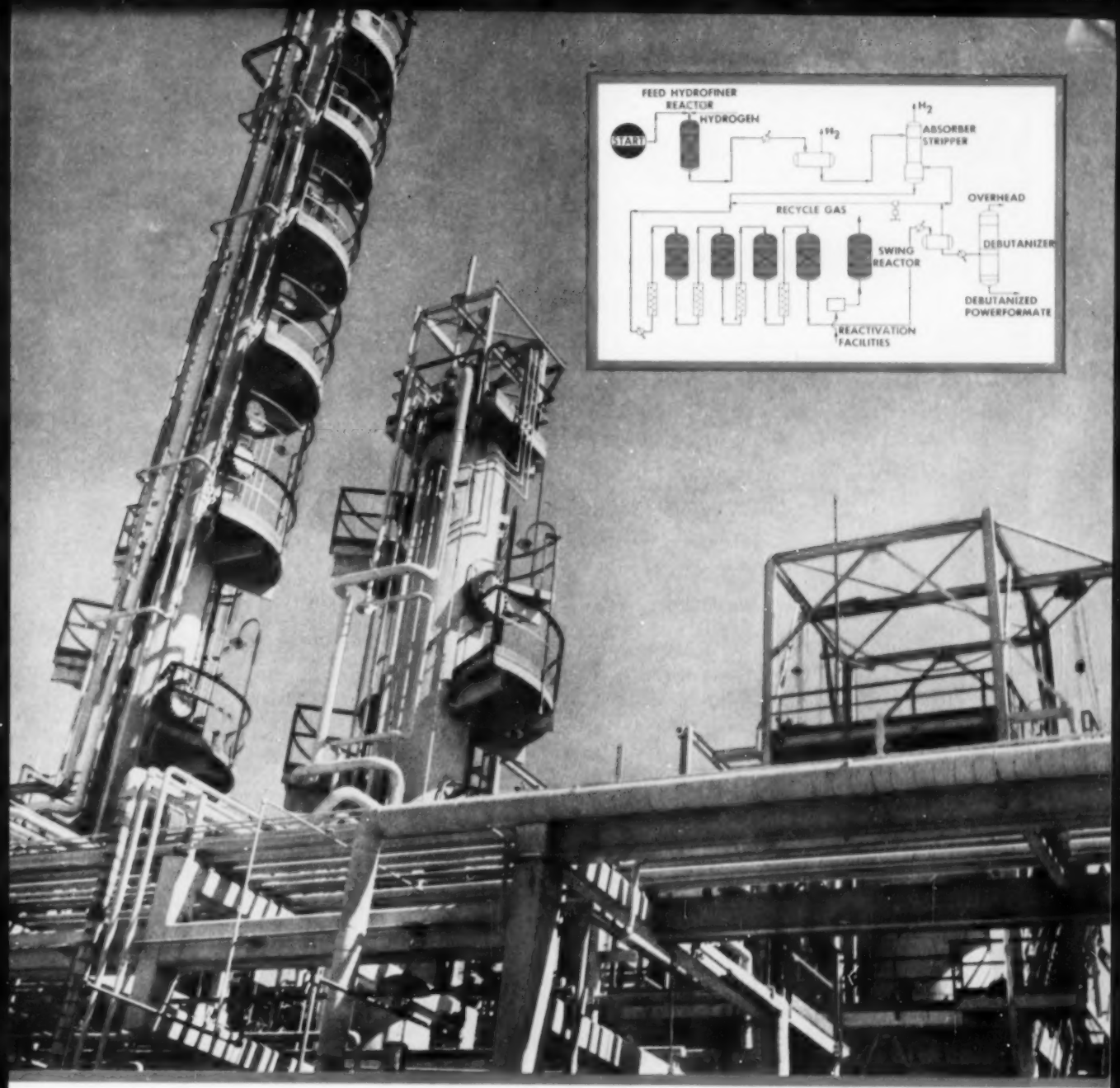
Humble Oil & Refining Co. has a new hydrocracking process, described by Gwin and associates, which also uses a cobalt molybdate on alumina catalyst, has very long onstream catalyst life (600+ hours), and operates at 725-825°F, 400-800 psig.

Asphalt conversions of 50-70%, with up to 105% volumetric yields (based on asphalt feed), are shown for the Humble process. As in the Houdry process, emphasis is on materials in the gas oil range, with a product of 2-12 vol% naphtha, 10-25 vol% heating oils (somewhat high in aromatics, thiophenols and mercaptans), 17-31 vol% gas oil acceptable for catalytic cracking, and a 1000°F+ residual product which can be used as refinery fuel or blended into Bunker C fuel oil.

Humble's general purpose hydrogenation pilot plant is further described in a third paper by Boynton, Manne and Souby.

There is no doubt that the use of hydrogen in the refinery is firmly established as shown in the Special Report on pp. 115-138 of this issue. However, hydrocracking has had only limited use in the U. S. to date.

The work by Houdry, Humble, and many other oil companies may change the picture, and make hydrocracking one of our accepted processing techniques. In any event, hydrocracking is now so close to economic feasibility that it could be attractive in some special cases, or if there is a big chance in supply and demand, we may find many refineries using hydrocracking. —R.L.D.



POWERFORMING PROCESS CAN INCREASE YOUR HIGH OCTANE YIELD

Esso Research and Engineering Company offers you *Powerforming*, the most versatile platinum reforming process ever developed. *Powerforming* is another achievement of the Esso Research program – 37 years of new process developments which have been made available to refiners around the world.

Heart of the *Powerforming* process is a new, more active platinum catalyst. High activity over a long life is assured by significant new regenerative techniques. With this new process, good yields of 100 octane clear Powerformate can even be obtained from paraffinic stocks. Three *Powerforming* installations are on stream; eighteen are in the planning or construction stage. Licensees enjoy benefits of continuing *Powerforming* research. We would welcome your inquiry on the part *Powerforming* can play in *your* modernization plans.

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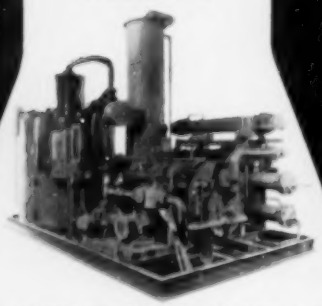
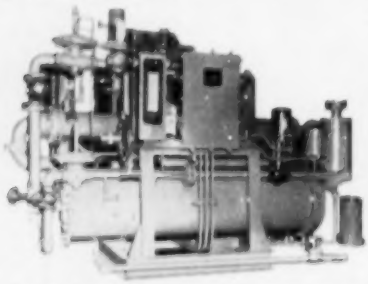
Your key to progress... an Esso Research process

Gas Atmospheres is moving fast with Petrochemical Progress

Pace setting gas generation systems boost quality, safety in petrochemical production



Gas Atmospheres Hi-Purity Nitrogen Generators are available in capacities from 250 SCFH to 40,000 SCFH.



Gas Atmospheres Inert Gas Generators are available in single unit capacities from 250 SCFH to 150,000 SCFH.

No other generator manufacturer surpasses the ability and experience of Gas Atmospheres in producing complete systems for petrochemical processing. Gas Atmospheres Hi-Purity Nitrogen and Inert Systems are being used by most leading petrochemical processors for blanketing, purging or packaging such products as acetone, methanol, formaldehyde, acetaldehyde, butadiene, synthetic fibers, etc.

gas Atmospheres, inc

equipment for producing industrial gases

20011 WEST LAKE ROAD CLEVELAND 16, OHIO

Letters

Hydrogen Treating

To The Editor: I read with great interest your article "Chemical and Hydrogen Treating" by W. W. Scheumann (April, 1956, pp. 53-57).

At the present time, 95% of the crude processed in Italy is of Middle East origin, with a high sulfur content. As far as gasoline is concerned, catalytic desulfurization methods have been found which enabled the refineries to eliminate about 90% of the sulfur, obtaining gasoline grades with octane number up to 100 (Research).

As to kerosine, no desulfurization system has been found as yet—at least not practical.

According to the article, it appears that through the Doctor-Acid-Clay treating method a good grade of refined kerosine could be obtained. Can Mr. Scheumann provide us with the following analytical data of both the distilled and refined kerosines: Doctor test, ASTM distillation, percent aromatic hydrocarbons, sulfur, smoke point, color, and char value.

Also, would it be possible to obtain a good grade of refined kerosine only with 66° Be, 93% sulfuric acid, neutralization with NaOH, washing with water, without redistilling the product as described in the article?

Ing. George Morarin
Astra Petreol
Via Livenza 7
Rome, Italy

● *For a reply to Reader Morarin, we turned to Author Scheumann, who said:*

. . . As you are aware, the major requirements for a good grade of kerosine are: good color, no objectionable odor, and good burning characteristics. The first two are thought to be linked with sulfur compounds in the oil, while the latter appears to be largely a function of the aromatics content of the kerosine.

In our particular operation, we are called upon to process not only sweet crudes, but large quantities of high sulfur crudes as well. The process our company employs to treat the kerosine fraction from these mixed crudes may be termed the Doctor-Acid-Clay process.

In this system the raw kerosine is first reacted with doctor solution (alkaline sodium plumbite and elemental sulfur) in order to convert the mercaptans to disulfides. The disulfides

(To obtain more data on advertised products see page 182)

remain in the oil. Following the doctor treat, the kerosine is contacted with approximately 3 lb/bbl of 93% sulfuric acid.

The acid treatment serves a multifold purpose. A portion of the disulfides formed in the doctor treatment are removed by preferential solvent action of the sulfuric acid. In addition, sulfides, polysulfides, and thiophene are partially extracted. Aromatics, which are objectionable due to their poor burning characteristics, are reduced somewhat by the acid treat. The acid is also said to improve the color of the finished kerosine, possibly due to the extraction of higher molecular weight color bodies.

The third and last step is that of clay contacting. This removes the last traces of acid sludge carried over from the acid settlers, as well as imparting a finished color to the kerosine.

The kerosine thus treated has a 30 NPA color, is sweet to the doctor test, has no objectionable odor, is noncorrosive to copper, has good burning characteristics, and is stable in storage.

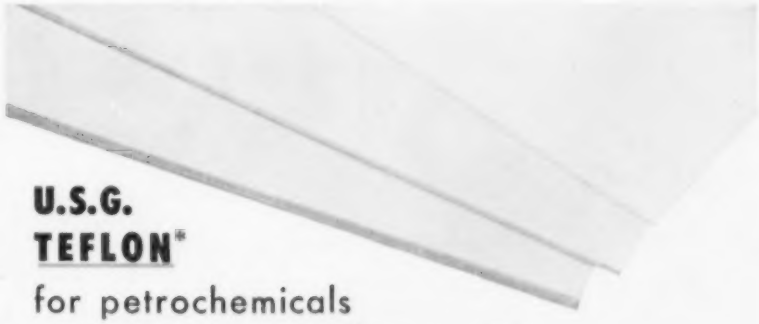
As to the question regarding the possibility of producing a finished kerosine by acid treating followed by caustic and water washing: it is felt that at least a portion of the product requirements could be met by such a process.

Sulfuric acid of 93% would theoretically convert mercaptans to disulfides and would partially remove these as well as sulfides and polysulfides by solvent action. Aromatics would also be extracted by strong sulfuric acid.

This treatment could produce a kerosine having good burning qualities, no objectionable odor, and good stability. However, it must be pointed out that 93% sulfuric acid in any reasonable acid-to-oil ratio will not effect complete sulfur removal. The question of good color remains in doubt. Even though the subsequent caustic and water washes remove all pepper sludge, it may be necessary to pass the kerosine through a filter clay in order to obtain the required color improvement.

Deterrents to a strong acid treatment are that a sizeable product loss is encountered due to sludging. If process conditions are not carefully controlled, it is possible to "burn" the kerosine, producing an off-color product which is not rendered clear by clay treating. . . .

W. W. Scheumann
Vice President
Cities Service Research
& Development Co.
New York 5, N. Y.



U.S.G. TEFLON*

for petrochemicals

Inert to all chemicals (excepting molten alkali metals and fluorine at elevated temperatures). Available in sheets from ½" up. Also in cut gaskets to specification and in envelope gaskets with compressible filler materials for all standard pipe flanges.

Write for U.S.G. Bulletin No. 300 (sheets) or Bulletin TG-456 (Gaskets).

United States Gasket Company
Camden 1, New Jersey

here's the answer to sheet packing problems

BELMONT NEOPRENE

for oils and solvents

Belmont Neoprene sheet packing has high resistance to petroleum products, alcohol, caustics and many acids. It has high tensile strength and has good abrasion resistance.

Available in standard rolls, 40" wide by 10 yards long, in thicknesses from ⅛" to ¼" inc. and in durometer hardnesses of 40, 50, 60, 70, 80 and 90.

Also available in cut gaskets.

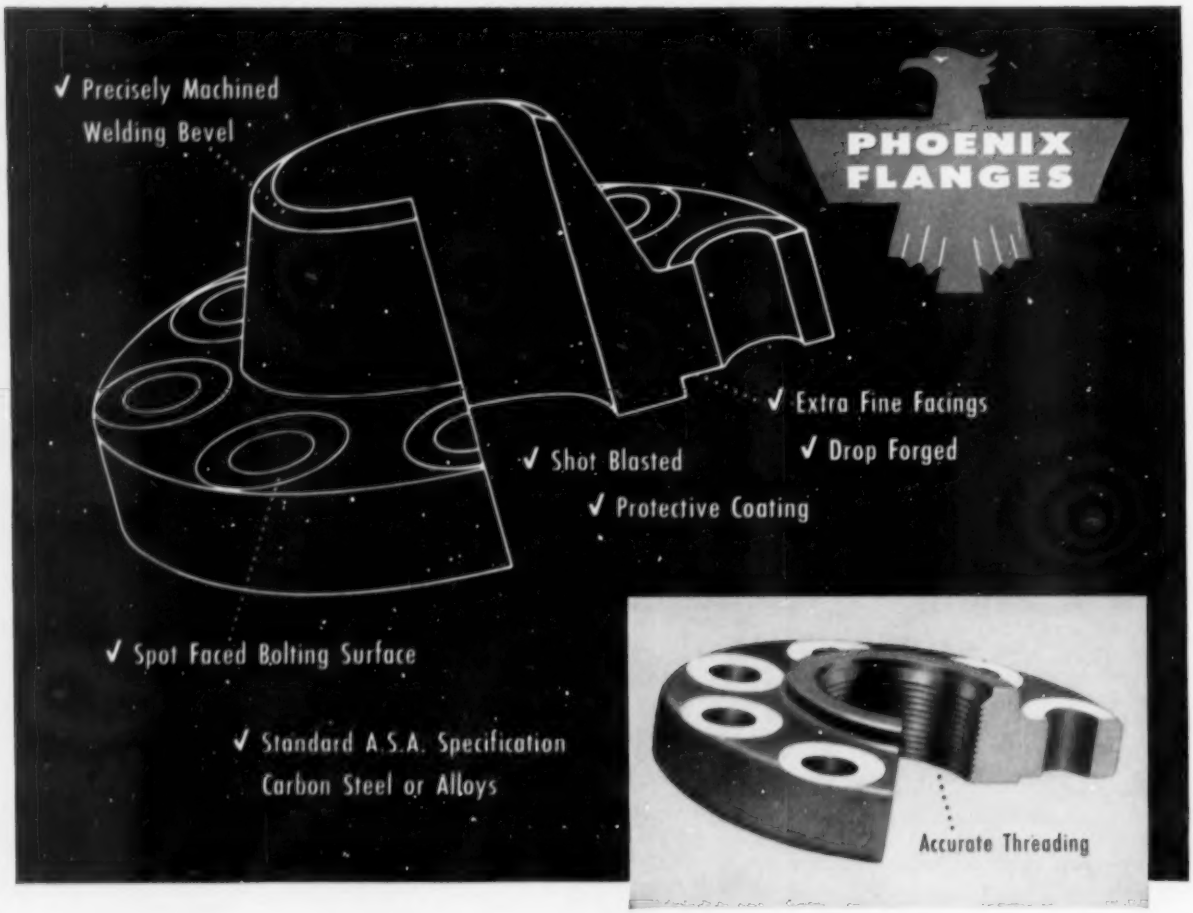
Write for Belmont Catalog No. 56.

The Belmont Packing & Rubber Co.
Butler & Sepviva Sts., Phila. 37, Pa.

*du Pont's trademark for its tetrafluoroethylene resin.

U. S. GASKET · BELMONT PACKING

UG BELMONT



PHOENIX QUALITY STANDS OUT ALL OVER

We needn't tell you what kind of life and service you demand from the pipe flanges you buy. The important thing to know is that you are ordering flanges which will be consistently high in quality. Phoenix drop-forged flanges *always* meet the highest quality and strength specifications. No one makes a better flange!

SPECIAL MACHINED FLANGES AVAILABLE
SPECIAL FACINGS • BORES • DRILLING • THREADING

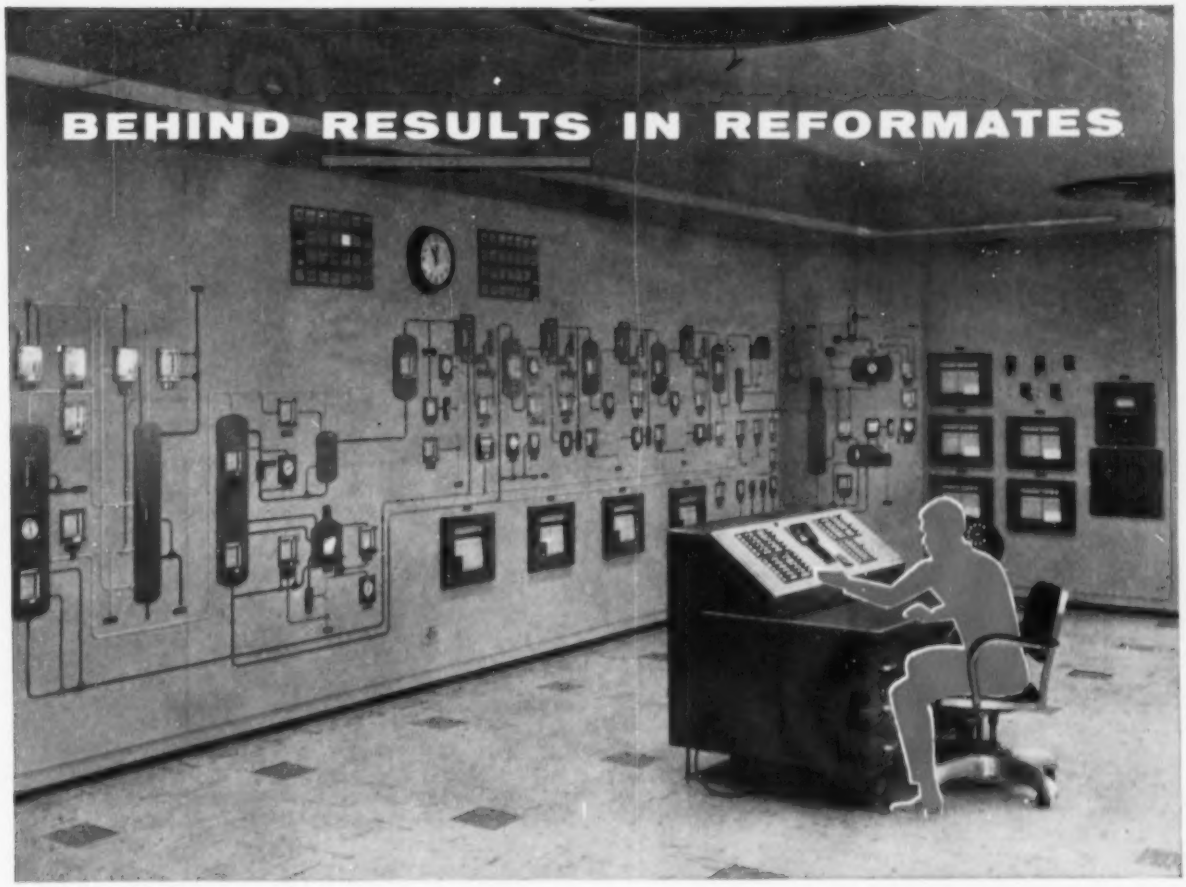
Leading Manufacturers of Pipe and Tank Flanges and Commercial Forgings

PHOENIX

FLANGE AND FORGING DIVISION
PHOENIX MANUFACTURING COMPANY
CATASAUQUA, PA. • JOLIET, ILL. • FOUNDED 1862

Integrated Manufacturing Facilities: FLANGE AND FORGING DIVISION, STEEL BAR MILL DIVISION, RUBBER PRODUCTS DIVISION AND HORSESHOE PRODUCTS DIVISION

(To obtain more data on advertised products see page 182)



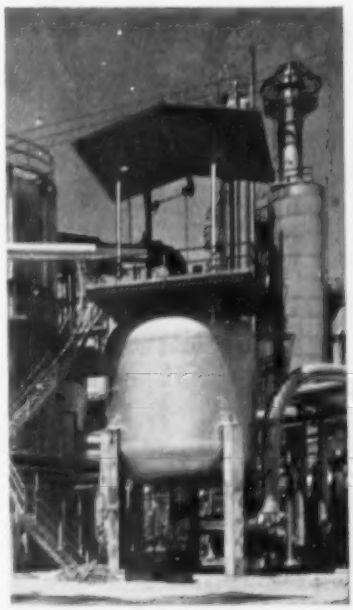
Another Kellogg Example of Engineering Teamwork

Above is the control room for Sinclair Refining Company's modernized refinery at Houston, showing instruments at the right for one of the largest and most efficient cat reformers ever built. Designed for 24,000 BPD of 95 octane clear (101 leaded) on a 3-reactor blocked-out system, this reformer is the result of engineering teamwork between Sinclair Refining Company and The M. W. Kellogg Company. It typifies M. W. Kellogg's ability to work harmoniously with oil refiners toward the optimum solution to a specific refining problem.

This cat reformer is the second to be erected by The M. W. Kellogg Company using Sinclair-Baker regenerative catalyst RD-150. Process and catalyst together provide a new and economical way for Sinclair to increase yields from present feedstocks and to get high octane reformates from low grade naphthas.

Kellogg-designed cat reformers, engineered from the laboratory and pilot plant data of both Kellogg and Sinclair, enable refiners to obtain reformates of 100 octane clear with naphthas from Kuwait crudes, and 102 with naphthas from Mid-Continent crudes. Quick start-up is assured. Cost of catalyst per barrel of reformate is lowered. A major Kellogg contribution is the desulphurization phase of the process, which sharply reduces equipment corrosion and catalyst contamination.

Nine other catalytic reforming units of this process design are now on M. W. Kellogg's drawing boards for major oil refiners. All will yield reformates of 95 octane clear or better.



One of three reactors for the catalytic reformer at Sinclair's Houston refinery.

REFINERY PROCESS DIVISION

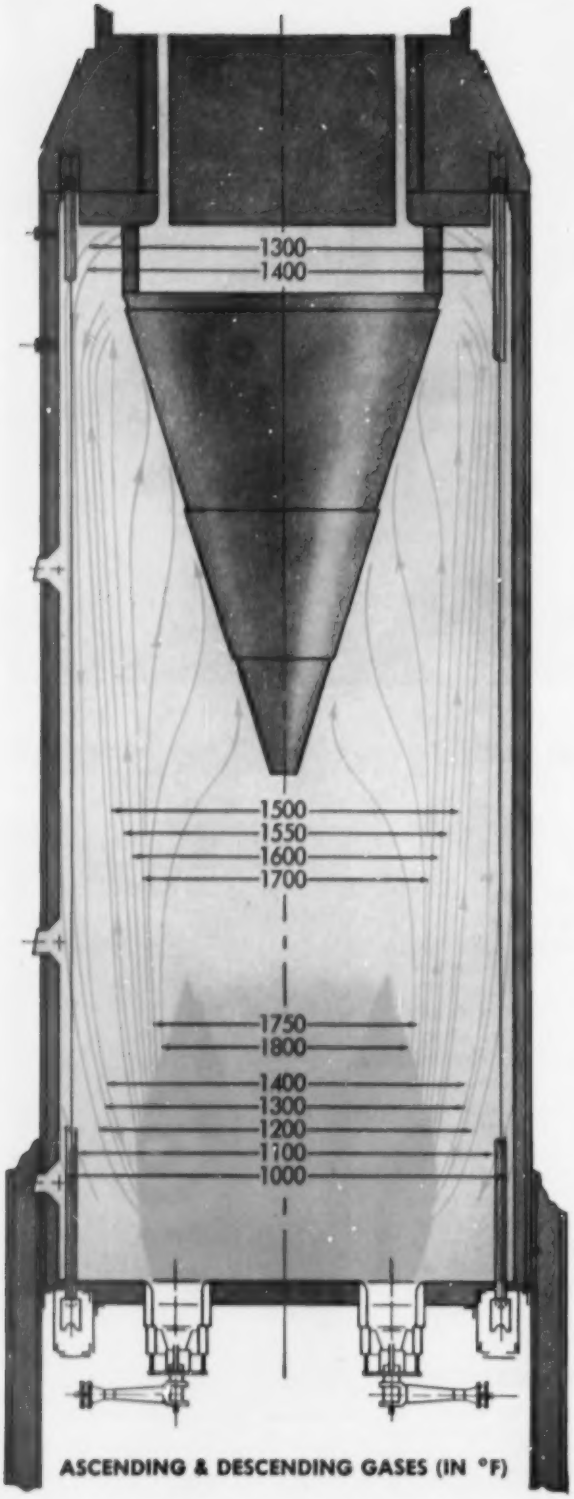
The M. W. Kellogg Company

711 THIRD AVENUE, NEW YORK 17, N. Y.

A SUBSIDIARY OF PULLMAN INCORPORATED

The Canadian Kellogg Company Ltd., Toronto • Kellogg International Corp., London • Kellogg Pan American Corp., New York
Société Kellogg, Paris • Companhia Kellogg Brasileira, Rio de Janeiro • Compania Kellogg de Venezuela, Caracas

PETROCHEM-ISOFLOW FURNACES



ASCENDING & DESCENDING GASES (IN °F)

Here are the facts!

The first vertical cylindrical heaters provided even circumferential heat input, but vertical flux distribution varied considerably, from high transfer at the bottom of the tubes to low rates at the top. Improvements in design during the past twenty years have overcome this difficulty, by providing proper firebox proportions, a reradiating cone, and burners specifically designed to the requirements of the furnace.

It is significant that *only Petrochem-Isoflow furnaces* incorporate all three of these critical items of design.

The small, hot cone tip reradiates to the tubes, across a considerable distance. Because of the conical shape employed, each higher element of the cone is of larger area, and closer to the tubes than the section below. These factors compensate for decrease in cone temperature from tip to base, provide relatively constant radiant heat transfer over entire upper tube length.

The cone also serves to divert flue gases along the upper ends of tubes, which adds convection heat transfer over this length. It also initiates a high rate of firebox recirculation of combustion products, by cooling the gases in their passage across the tubes.

Being cooler, and therefore heavier than the rising gases in the center of the firebox, the gases adjacent to the tubes fall to the bottom of the heater by thermal siphon effect, increasing the heat input to the rear of the heating elements by convection. The descending gases also serve as a buffer between hot gases and the lower ends of the tubes and dilute the products of combustion. The special burners, by developing a symmetrical flame pattern, contribute to the equality of heat distribution over the entire radiant tube length.

Of the design features mentioned above, the cone is of the greatest significance because it is essential to even radiant heat distribution.

Experienced operators know that even heat distribution improves product quality, decreases tube deteriorations, results in longer, trouble-free operating cycles.

The Data Shown in the Drawings are ACTUAL PERFORMANCE RECORDS!

To check radiant flux distribution in Petro-Chem furnaces, exhaustive tests were made under actual operating conditions; some of the results of these tests are indicated in the two adjacent drawings.

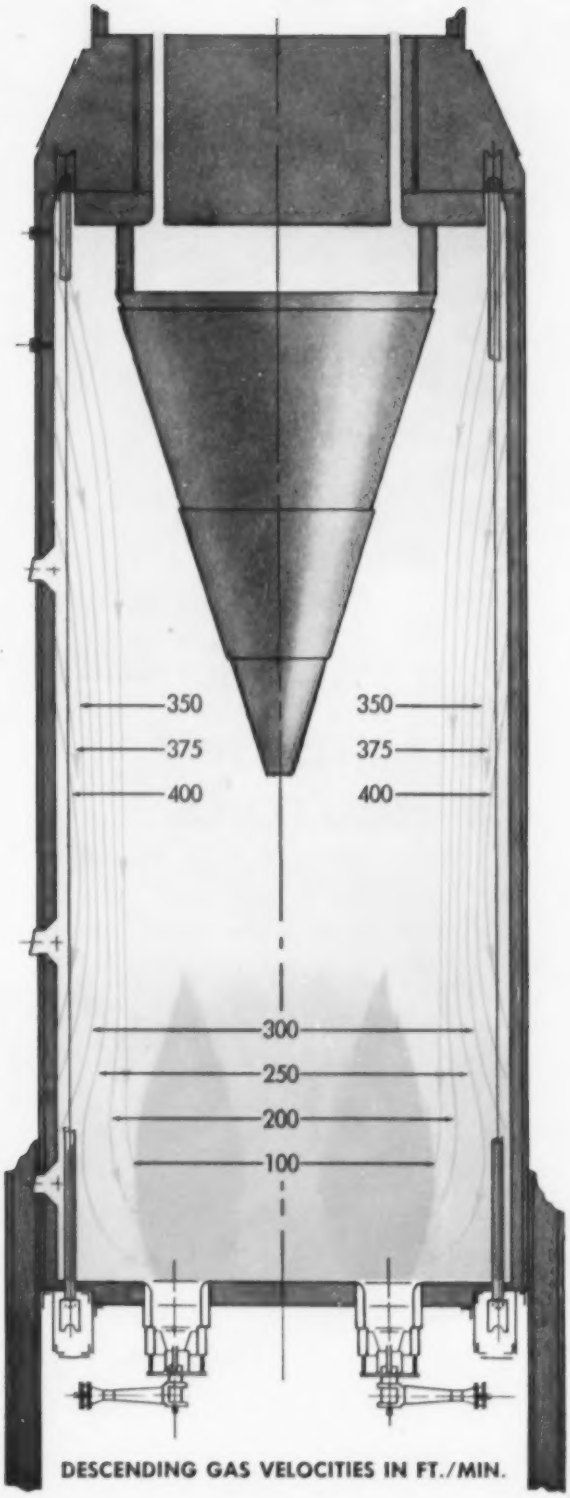
Left: Plot of isotherms in a Petrochem-Isoflow firebox, illustrating the uniformity of firebox temperature.

Right: Plot of flue gas flow patterns and velocities, demonstrating the high gas recirculation rates.

Both of these phenomena are the result of proper firebox proportions, the two-fold action of the cone, and symmetrical flame pattern.

(To obtain more data on advertised products see page 182)

Provide EVEN HEAT Distribution !



In addition to even heat distribution, other all-important factors which determine the value and efficiency of processing furnaces include:

MAXIMUM FUEL EFFICIENCY
PLENUM CHAMBERS FOR HAZARDOUS AREAS
SIMPLICITY OF DESIGN AND CONSTRUCTION
EXCESS DRAFT FOR HIGH OVERLOAD
EXPLOSION RESISTANT
MINIMUM GROUND SPACE
SHORT LENGTH OF LIQUID TRAVEL
ZERO AIR LEAKAGE
LOW PRESSURE DROP
LOW MAINTENANCE

In every case where these 11 all-important design characteristics were employed to compare one type of furnace design with another, PETROCHEM-ISOFLOW FURNACES were proved more economically desirable by any comparison.

More than 1350 Petrochem-Isoflow Furnaces have been installed since 1940—an unequalled record of acceptance based on proved performance.

PETROCHEM
—ISOFLOW FURNACES

UNLIMITED IN SIZE . . . CAPACITY . . . DUTY

PETRO-CHEM DEVELOPMENT COMPANY, INC.
122 East 42nd Street, New York 17, N. Y.

REPRESENTATIVES:
Rawson & Co., *Houston* • William H. Mason Co., *Tulsa* • Lester Oberholtz, *Los Angeles* • Faville-Levally, *Chicago* • D. D. Foster, *Pittsburgh* • Turbex, *Philadelphia* • Flagg, Brackett & Durgin, *Boston* • G. M. Wallace, *Denver & Salt Lake City*

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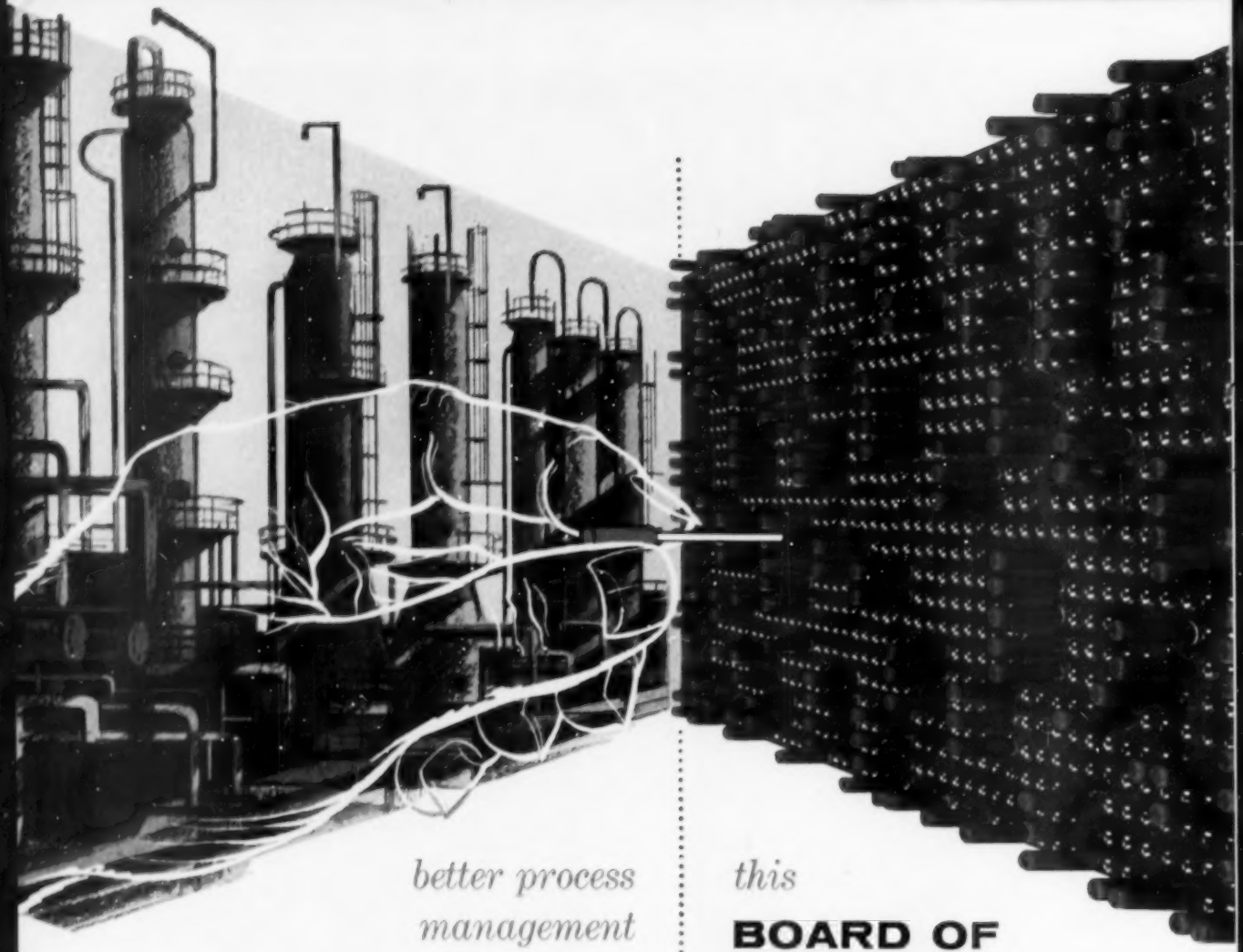


better process management starts with

this

BOARD OF DIRECTORS

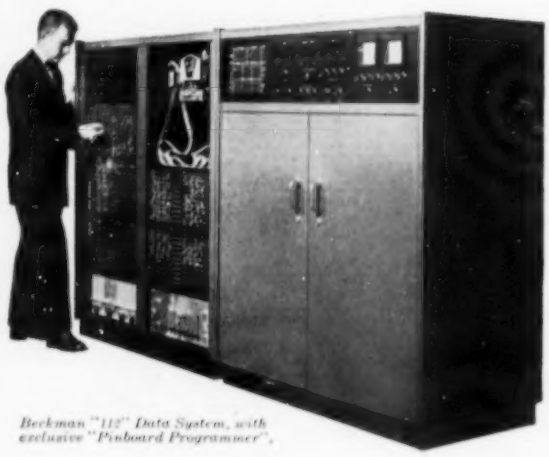
Whether you're responsible for managing a company or controlling a process, the Beckman "112" Data System – with exclusive PINBOARD PROGRAMMER – will help you do a better job.

How? By bringing you a *greater quantity* of *more accurate* operating data–in *useful* form–*immediately, instead of in days or weeks!*

Simply pin your instructions on the Pinboard, which, in turn, automatically directs the system to monitor the desired number of variables; record data on log sheets, cards, or tape; calculate material balances and product yields, and perform other functions. You are given a continuous picture of your plant operation–a chance to correct off-normal conditions and inefficiencies quickly, increasing product yield and quality.

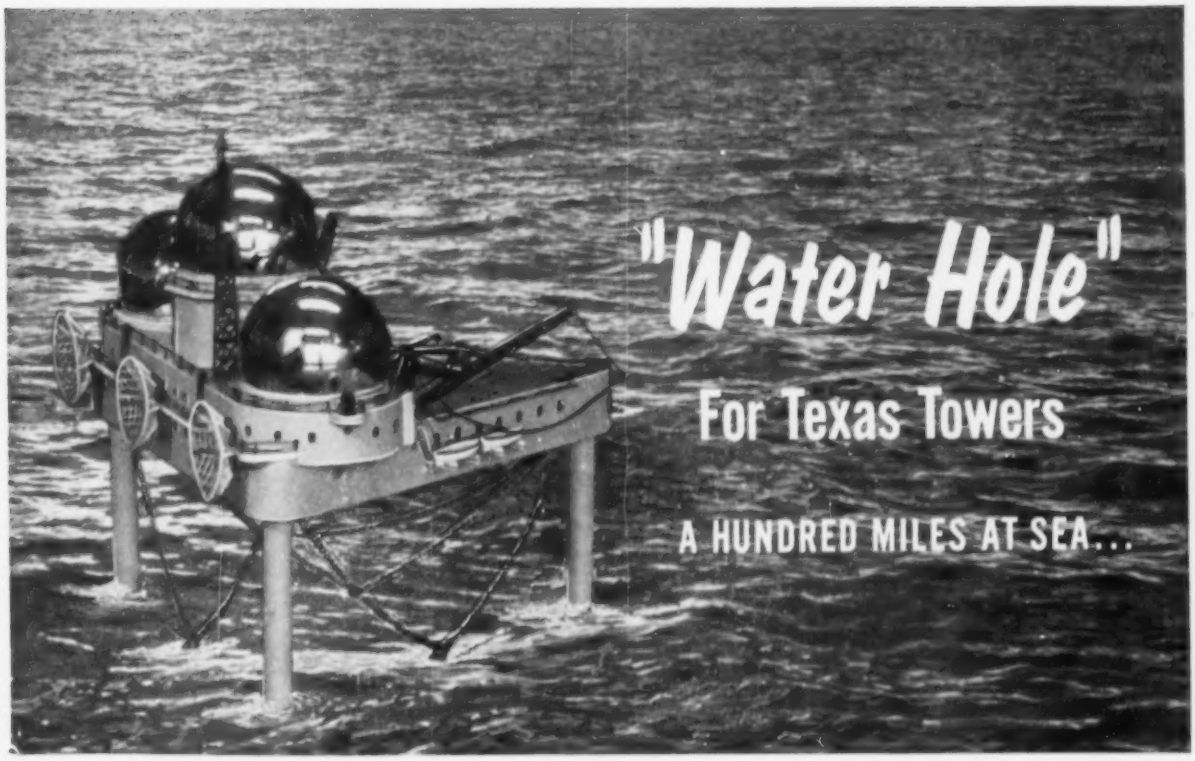
"Magnetic core logic" – "floating" – semiconductor circuitry. Although these features in the "112" are of primary interest to the technical man, to the top executive they mean round-the-clock, round-the-calendar accuracy and reliability–data you can depend on, all the time. For complete information, write Beckman Instruments, Inc., Data and Control Systems Dept., Fullerton, Calif. Ask for Data File D-2-23.

Our continued growth creates openings for creative engineers. Write for Career File No. 10.



Beckman "112" Data System, with exclusive "Pinboard Programmer".

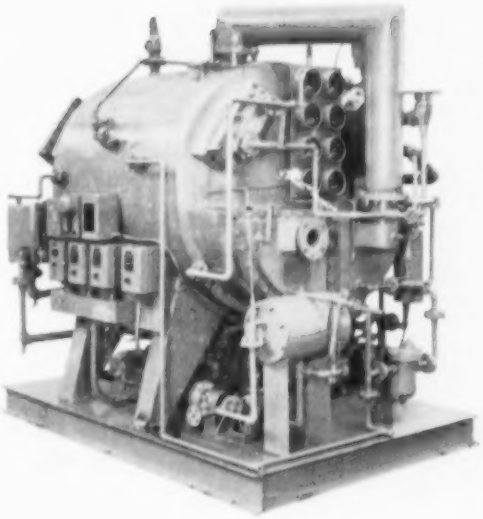
Beckman / *scientific instruments*



Early-warning radar stations, standing far out in the open ocean, need plenty of fresh water—for drinking as well as other purposes. And to supply it, they depend largely upon sea water evaporators using Bridgeport condenser tubes.

In these installations Bridgeport 90-10 Cupro Nickel Tube was chosen because of its excellent service in evaporators handling sea water. Its resistance to general impingement corrosion at high velocities often offers unique advantages over other alloys in many applications.

This is but one of many effective applications of a particular Bridgeport Condenser Tube Alloy —carefully selected to give optimum performance on a specific job. Bridgeport's Technical Service will be glad to help you select from a wide range of Bridgeport alloys the one tube best suited to your particular operating conditions. Call your nearest Bridgeport Sales Office for complete information.



Pure, fresh drinking water for "Texas Towers" is distilled from the sea by a Cleaver-Brooks Sea Water Evaporator equipped with Bridgeport Cupro Nickel Condenser Tubes.

BRIDGEPORT BRASS

Offices in Principal Cities • Conveniently Located Warehouses

Bridgeport Brass Company, Bridgeport 2, Connecticut
In Canada: Noranda Copper and Brass Limited, Montreal

BRASS Bridgeport CO

IN THE *Octane Derby*...

no refiner will be happy .

Like it or not, every refiner today must look to his octanes. As a matter of competitive survival it is vital that your refining processes provide maximum quality to every gallon of gasoline produced.

Today's, and tomorrow's, increasing demand for higher octane fuels cannot be met by one high octane stream. No matter how good that one stream, there isn't enough of it to bring pool octanes up to required levels; and the higher you raise the quality of that stream the less you'll get.

This is why UOP has consistently devoted much of its research to the over-all development of more practical refining methods, the broad goal of helping you get the most out of every drop of oil that passes through your refinery.

An important result of this work is Universal's latest refining process—PENEX. This new process offers an efficient and practical method of up-grading pentane and hexane fractions, the previously neglected components that can so adversely affect the octane ratings of your pool gasoline.

In the race for higher octanes, you cannot afford to forget that the goal is to improve the general quality of your pool gasolines. PENEX offers a means of accomplishing this practically and economically. It should be given immediate consideration in your planning.

UOP®

UNIVERSAL OIL PRODUCTS COMPANY

30 ALGONQUIN ROAD,
DES PLAINES, ILLINOIS, U. S. A.

Forty Years Of Leadership In Petroleum Refining Technology

. way back here

PENEX

TRADEMARK

A new isomerization process for up-grading pentane and hexane fractions

your "rolling pipe line"

More than 2600 Olin Mathieson tank cars are in service every day shuttling between a score of production points and our customers to assure dependable delivery of Mathieson Chemicals.

In a sense, they form a "pipe line" connecting major consuming and producing areas. And, they perform the important function of balancing out local shortages and surpluses.

If you're ever caught short of an essential chemical raw material, the flexibility of a multi-plant producer can prove invaluable. Our "pipe lines" carrying caustic, chlorine, ammonia, sulphuric acid, methanol and organics may be the answer to your supply problems. Talk it over with an Olin Mathieson representative soon.

MATHIESON CHEMICALS

OLIN MATHIESON CHEMICAL CORPORATION

INDUSTRIAL CHEMICALS DIVISION • BALTIMORE 3, MD. 3954

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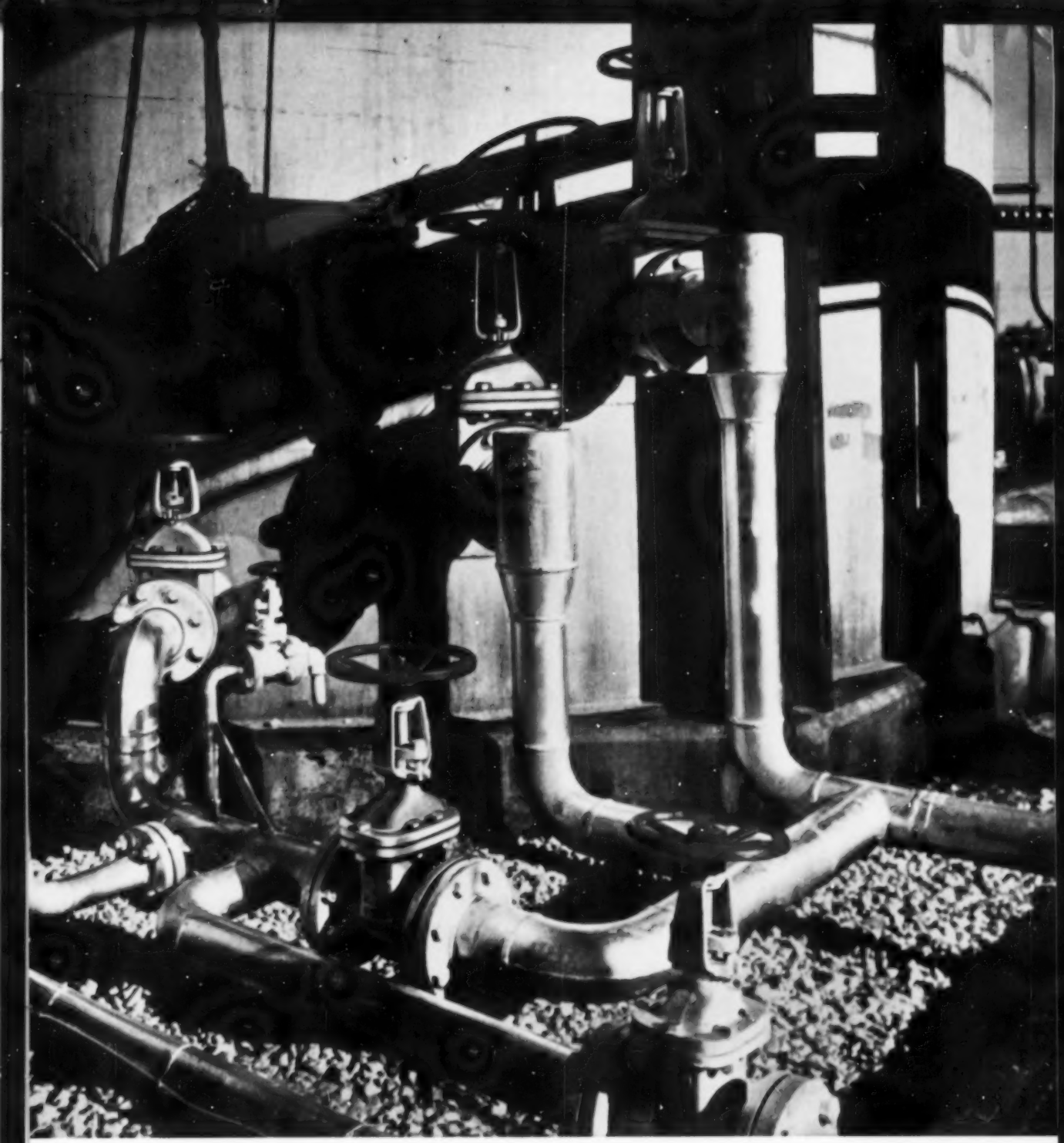
INORGANIC CHEMICALS: Ammonia • Bicarbonate of Soda • Carbon Dioxide • Caustic Potash • Caustic Soda • Chlorine • Hydrazine and Derivatives Hyprochlorite Products • Muriatic Acid • Nitrate of Soda • Nitric Acid • Soda Ash • Sodium Chlorite Products • Sulphate of Alumina • Sulphur (Processed) Sulphuric Acid • ORGANIC CHEMICALS: Ethylene Oxide • Ethylene Glycols • Polyethylene Glycols • Glycol Ether Solvents • Ethylene Dichloride • Dichloroethylether Formaldehyde • Methanol • Sodium Methylate • Hexamine • Ethylene Diamine • Polyamines • Ethanolamines • Trichlorobenzene • Polychlorobenzene • Trichlorophenol

(To obtain more data on advertised products see page 182)



Meet three synthetic detergent experts

You're looking at a Philadelphia installation of The Atlantic Refining Company (expert #1).

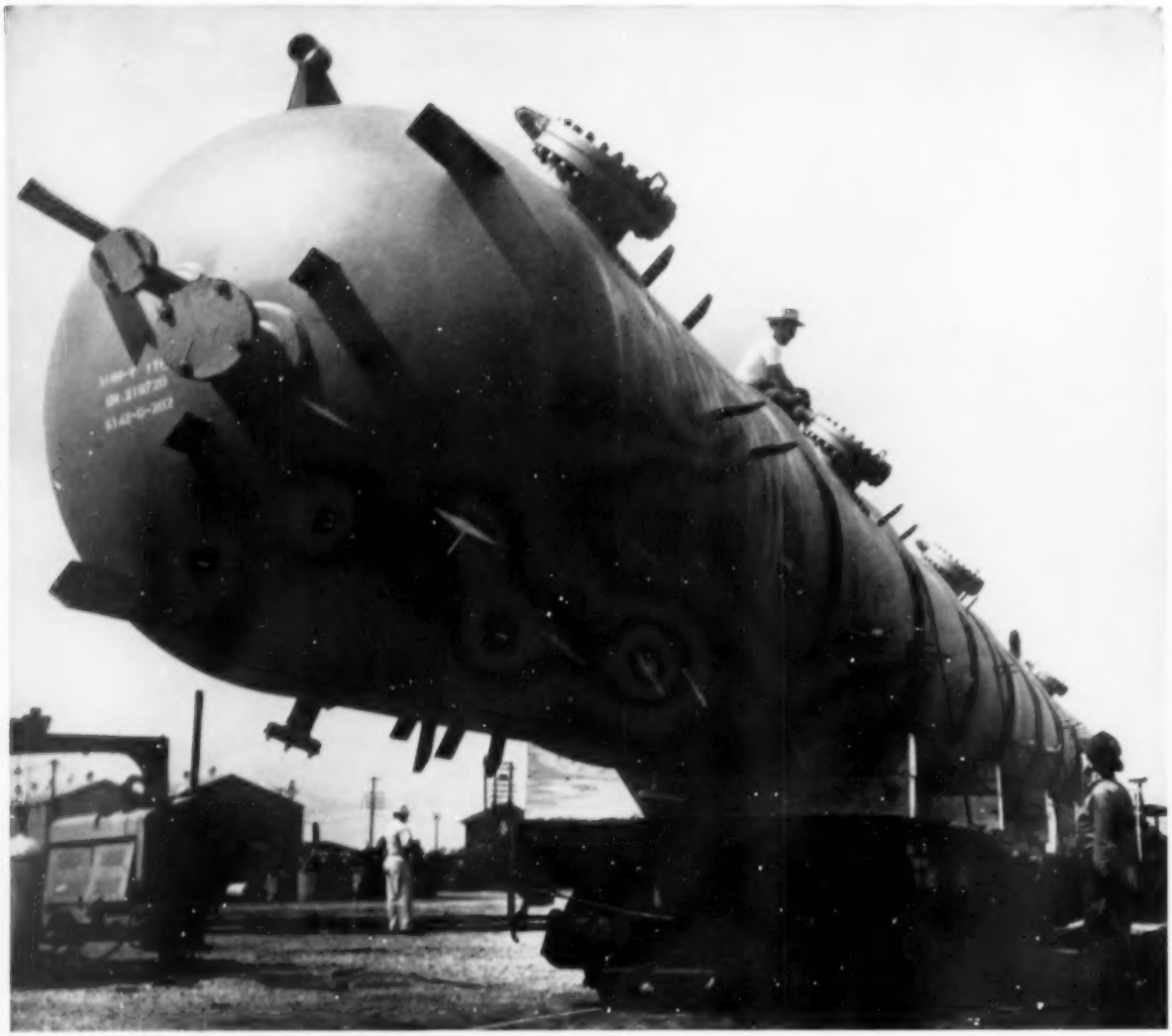
Ultrawet, an important ingredient of synthetic detergents, is the product being processed in this modern plant designed and built by The H. K. Ferguson Co. (expert #2).

Helping to prevent contamination of the product due to corrosion are long-lasting, red-wheeled valves made by Aloyco (expert #3). Made of corrosion-resistant Aloyco 20, the gate and globe valves used here handle a 98% concentration of sulfuric acid at up to 180° F.

Whatever your process, whichever corrosives you need to keep in line, it pays to check first with Aloyco. As the world's largest manufacturer of corrosion-resistant valves exclusively, we're most likely to have the valve you need. Write Alloy Steel Products Company, Inc., 1301 West Elizabeth Ave., Linden, New Jersey. 63

Longer Lasting
ALOYCO
VALVES
FOR IN CORROSIVE SERVICE

Subsidiary of Walworth Company



THIS ENTIRE VESSEL was radiographed. Built for use by Socony Mobil Oil Company, Incorporated, it was stress relieved in thirds, and the two joints were stress relieved locally. The unit contains 30 uniflex trays of 96" diameter. Overall weight: 152,000 lbs.

Among the largest in use

...built by Newport News

This Debutanizer with a 110 feet 6 inches over-all length is typical of units that are readily built by Newport News . . .

In fact, Newport News can fabricate almost any type of pressure vessel or other heavy equipment used in the petroleum, chemical or other processing industries.

But at Newport News you'll find more than large productive capacity.

In vast fabricating shops, in huge machine shops, foundries and forging plants, Newport News craftsmen complete your order with specialized techniques. Plant methods . . . developed as a result of specializing for more than half a century . . . enable Newport News to provide money-saving answers to all sorts of heavy equipment problems.

Newport News craftsmen handle the job exactly as you want it done . . . for maximum results per dollar invested. So let us bid on your present or future projects. Learn how Newport News can help you. Send for our illustrated booklet entitled, "Facilities and Products"...it's yours for the asking.

Engineers – Desirable positions available at Newport News for Designers and Engineers in many categories. Address inquiries to Employment Manager.

Newport News Shipbuilding and Dry Dock Company
Newport News, Virginia

IF YOU ARE CONCERNED WITH HIGH OCTANE OPERATIONS

INVESTIGATE THE EXTRA EFFICIENCY OF Sinclair-BAKER RD 150 PLATINUM CATALYST

BAKER'S RD 150 Regenerative Platinum Catalyst is a joint development of Baker & Company, Inc. and Sinclair Research Laboratories. This peak-production catalyst is now used with marked advantage by such companies as Sinclair, Socony and Pure Oil.

REGENERATES IN SITU . . . !

RD 150 provides high initial efficiency plus unique regenerative features. RD 150 assures greater yields at high octane levels, exceptionally long periods of operation, PLUS additional economy made possible by regeneration in situ! We are quite confident that the full story of Baker's RD 150 will be intensely interesting to you.

You can also be relieved of delivery and service problems. Modern Baker plants are geared for large-scale manufacture and refining for recovery of platinum from platinum catalyst.

Upon request, a Baker representative will be glad to consult with you and to furnish detailed information and recommendations.

BAKER & COMPANY, INC. CATALYSTS

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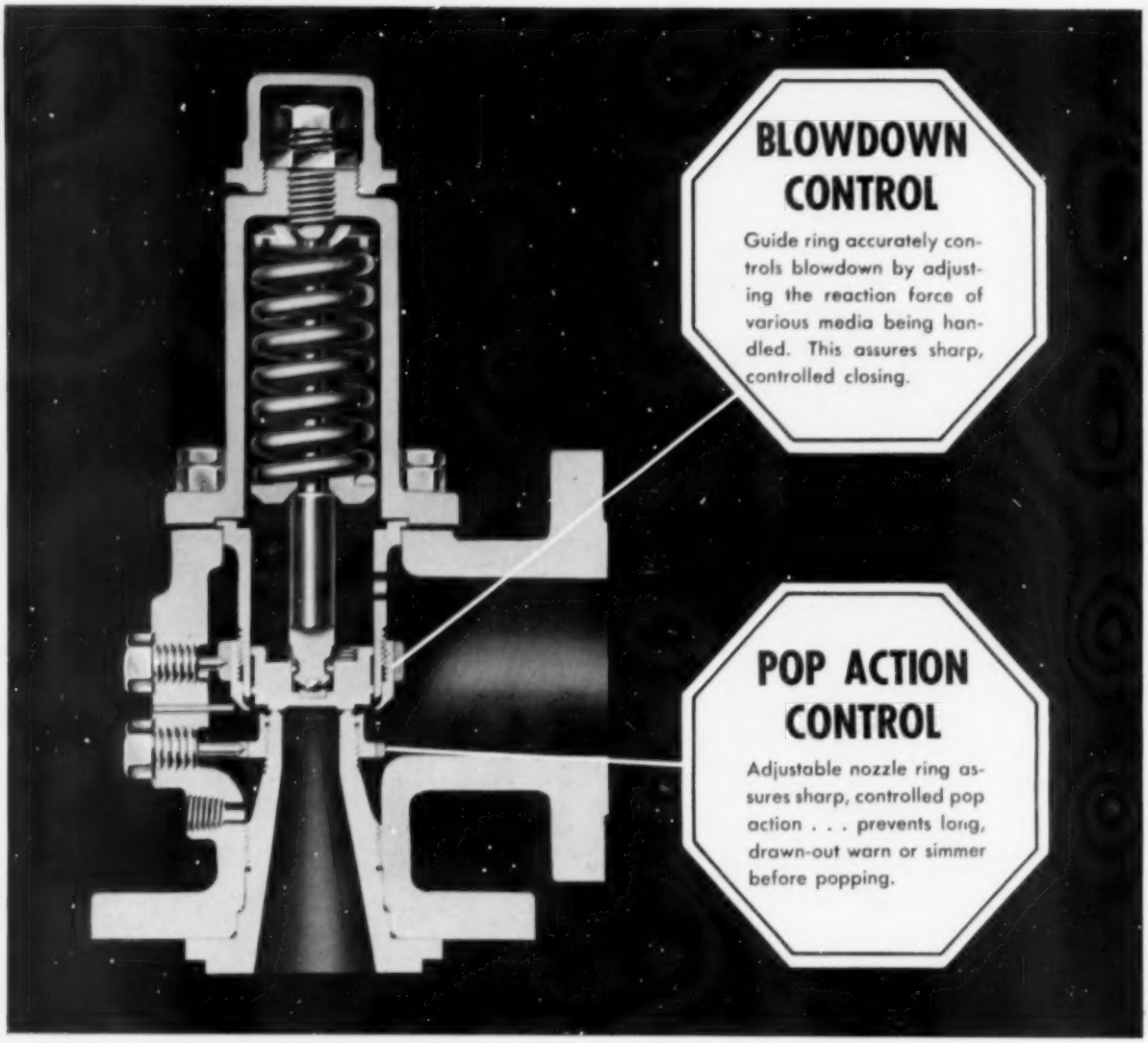
ENGELHARD INDUSTRIES

THE HUB OF PLATINUM METALS RESEARCH


BLOWDOWN CONTROL
Guide ring accurately controls blowdown by adjusting the reaction force of various media being handled. This assures sharp, controlled closing.
POP ACTION CONTROL
Adjustable nozzle ring assures sharp, controlled pop action . . . prevents long, drawn-out warn or simmer before popping.

Look for these Signs of Safety

PERFORMANCE is built into every Crosby Nozzle Type Safety-Relief Valve—in basic engineering, in quality materials, and in precision workmanship. Crosby Valves meet the needs of Industry for maximum operating dependability and minimum downtime and maintenance. Because they incorporate generous safety factors, these valves stay on the job for years.

Write for Bulletin describing the complete line of Crosby Relief Valves—or ask for our quote on your valve requirements.

CROSBY STEAM GAGE & VALVE COMPANY
43 KENDRICK STREET, WRENTHAM, MASS.

Crosby
KEEPS PRESSURE ON THE SAFE SIDE

 (To obtain more data on advertised products see page 182)

The REFINERY ENGINEERING Company's horizons are greatly expanded. Treco is now in position to offer engineering, design and construction of refineries, chemical plants, ore processing, secondary recovery and gas processing facilities on a world-wide basis.

The company has greatly enlarged engineering resources, research and development laboratories and a rapidly expanding staff. This enables The REFINERY ENGINEERING Company to offer a *complete service* to nearly all types of industries.

Treco has just produced a brochure which shows the Company's facilities with photographs of completed projects. A copy will be mailed you promptly upon request on your company's letterhead.

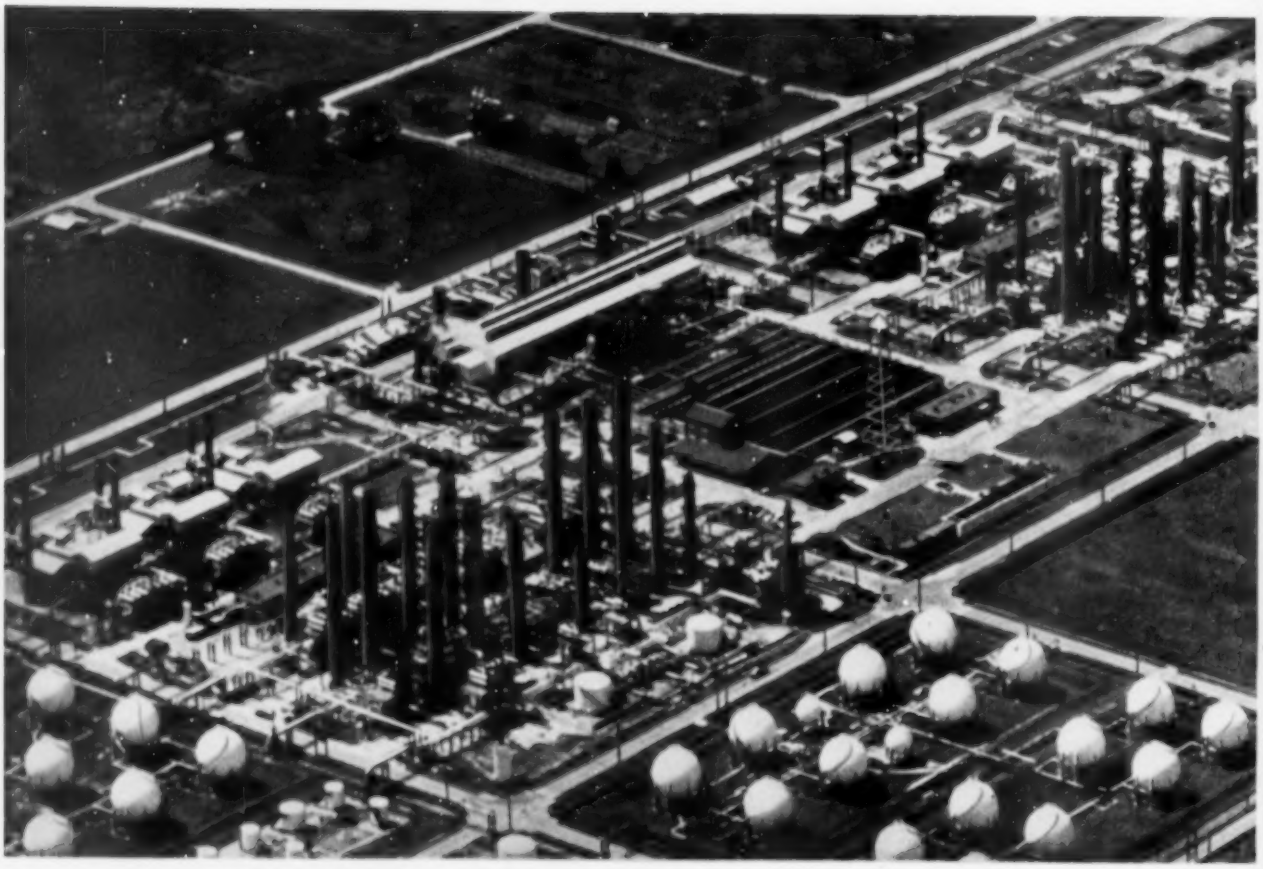
A DIVISION of VITRO CORPORATION of AMERICA

The REFINERY ENGINEERING Company

NEW YORK TULSA TORONTO

buta

Port Neches expansion,



Present facilities of the world's largest Butadiene plant – the Port Neches plant of Neches Butane Products Company – will be augmented by Foster Wheeler to effect a 50% increase in total capacity.

FOSTER

NEW YORK • LONDON

diene

200,000 to 300,000 tons/year

by Foster Wheeler

FOSTER WHEELER CORPORATION will provide process and mechanical design, engineering and construction for the expansion program at the Port Neches Butadiene plant of the Neches Butane Products Company. The plant, recently purchased from the government, is jointly owned by the Texas-U.S. Chemical Company and Goodrich-Gulf Chemicals Inc.

The present capacity of this plant, the largest in the world for the production of Butadiene, will be increased from 200,000 tons/year to 300,000 tons/year.

In addition to new process units, new steam generation, cooling water utilities and inter-plant facilities will also be provided by Foster Wheeler.

With engineering offices in New York, London, Paris and St. Catharines, Ontario, and complete fabrication facilities at Mountaintop, Pa., Dansville, N. Y., Carteret, N. J., St. Catharines, Ontario and Egham, Surrey, England, Foster Wheeler offers a world-wide service in the design, engineering, fabrication and construction of petroleum, petrochemical or chemical process plants or processing units.

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Increases Gasoline Yield
Lowers Unit Costs
Improves Products

QO Furfural sharply reduces many trouble-makers encountered in cat cracking. These include the refractory or carbon forming materials that overload the coke burning facilities of the unit and the heavy metal complexes that are notorious catalyst poisoners. Sulfur and nitrogen compounds are reduced substantially. Removal of these materials means increased through-put, increased gasoline yield, lower unit costs, and better product quality.

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For more complete information, write for our Bulletin 203-A "Physical Data on QO Furfural."

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the BIGGEST NEWS in expansion joints since the equalizing ring

New Zallea Duo Equalizing Expansion Joints represent a major advance in expansion joint design. Years of continuous research have resulted in an expansion joint that lasts longer, is substantially smaller and lighter, and has greater stability than any other available expansion joint.

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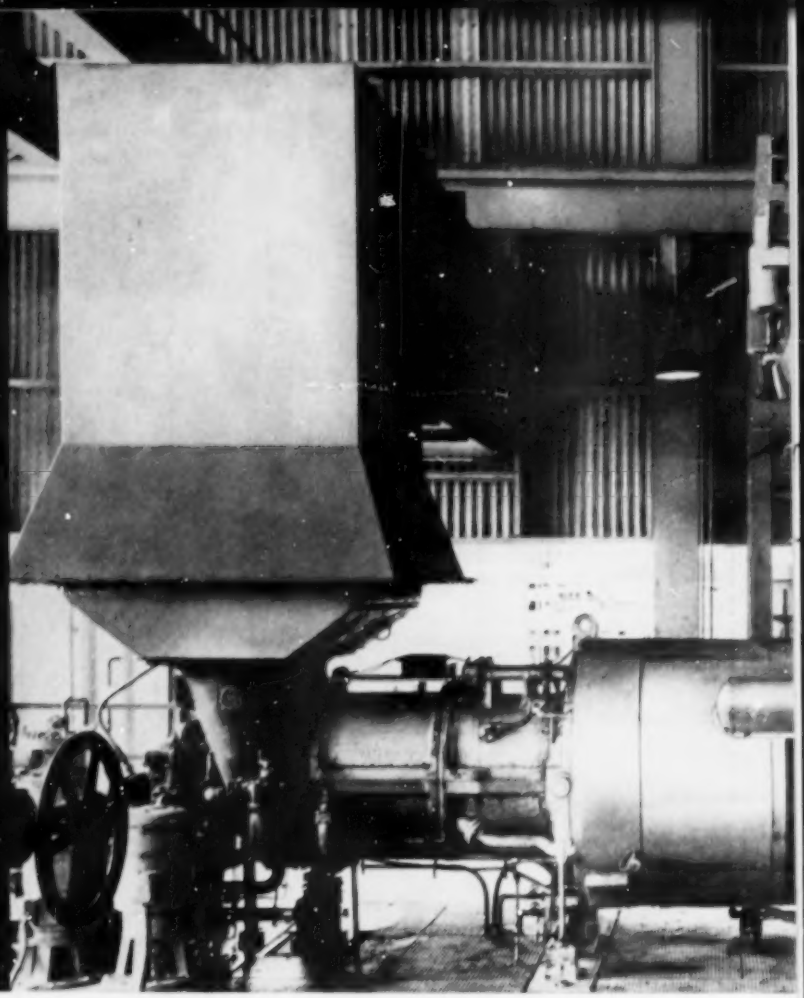
1. RESEARCH AND DEVELOPMENT

2. MANUFACTURING SKILL

3. ENGINEERING SERVICES

4. UNIT RESPONSIBILITY



IN REFINING process, General Electric gas turbine can supply shaft power, exhaust heat, compressed air. Above, turbine drives 3 compressors in tandem.

4 ways General Electric prime-drive systems

When you specify General Electric equipment, these product "added values" help you protect your equipment investment

TWO MAJOR FACTORS affecting your refining costs are unexpected equipment outages and maintenance. Here are four added values, offered by the General Electric Co., to help you protect your vital electrical system against breakdown and excessive maintenance.

1. **RESEARCH AND DEVELOPMENT:** To assure advanced design and construction, General Electric spent over three times as much, per sales dollar, on 1955 research and development than the average of all manufacturing companies.

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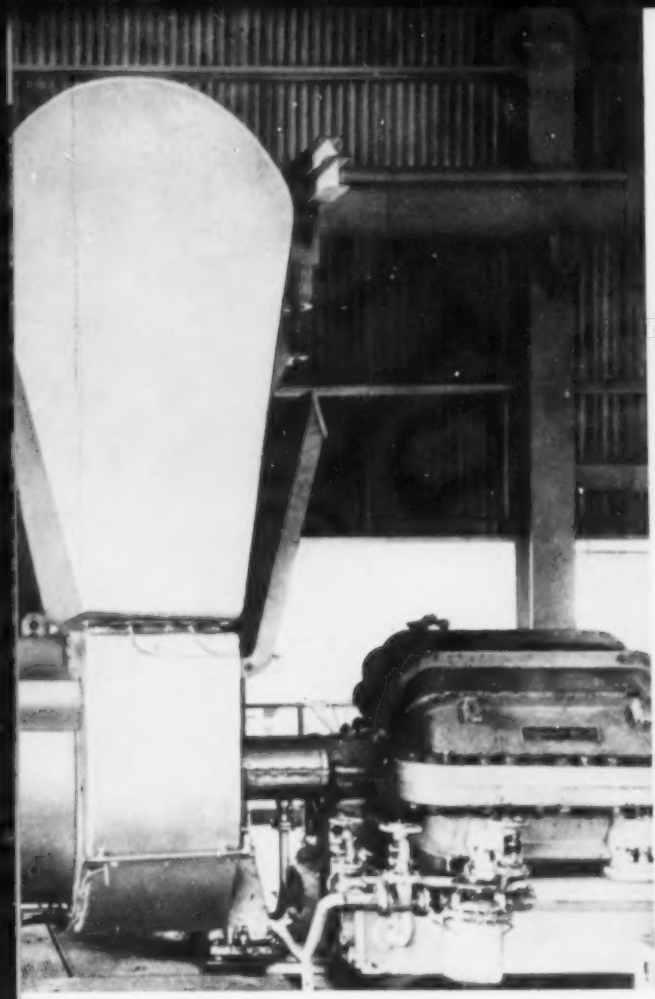
CONTACT your nearest General Electric Apparatus Sales Office early in your planning. And write for GED-1966C, "Electrical Equipment for Process Industries" and GED-2244, "Engineering Services" to General Electric Co., Section 681-14, Schenectady 5, New York.

Engineered Electrical Systems for Refineries

GENERAL ELECTRIC



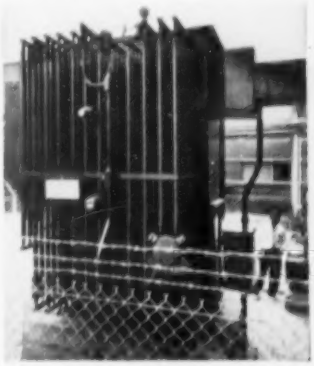
CONTROL for the gas turbine is completely centralized and requires very little actual supervision. After a few manual adjustments, the General Electric gas turbine automatically comes up to speed.

REPLACING six gas compressor drives, this General Electric 4000-hp induction motor application saved space, maintenance costs.

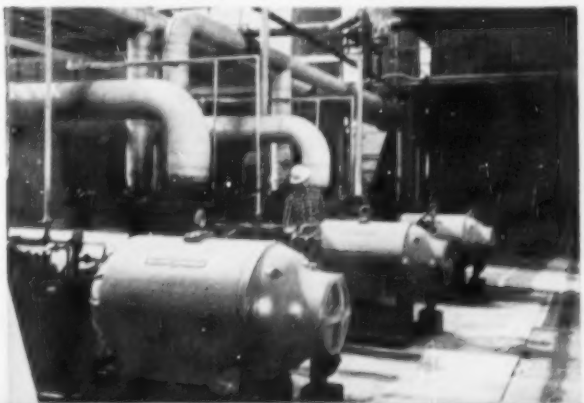
help lower refining costs

COMPACT G-E metal-clad switchgear helps protect and controls drives, requires little floor space, cuts installation costs.

INSTALLED faster because it was shipped completely assembled, 3750-KVA medium transformer supplies power to 4000-hp drive.



PROTECTED against corrosive atmosphere, fan cooled, explosion-proof, hot-oil pump motors need no protective housing.



Problem: **Lengthen time between turnarounds...**

Raise production...

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With a Ljungstrom stills stay on stream at top capacity months longer, because preheated air mixes more thoroughly with fuel. More complete combustion greatly reduces slag forming material. You generate higher flame temperatures, increase heat-transfer rates.

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For more complete details on what the Ljungstrom Air Preheater can do for you – for an analysis of the heat recovery benefits attainable in fuel burning equipment – call or write The Air Preheater Corporation.

Wherever You Burn Fuel, You Need Ljungstrom

The Ljungstrom operates on the continuous regenerative counterflow principle. The heat transfer surfaces in the rotor act as heat accumulators. As the rotor revolves, the heat is transferred from the waste gases to the incoming cold air.

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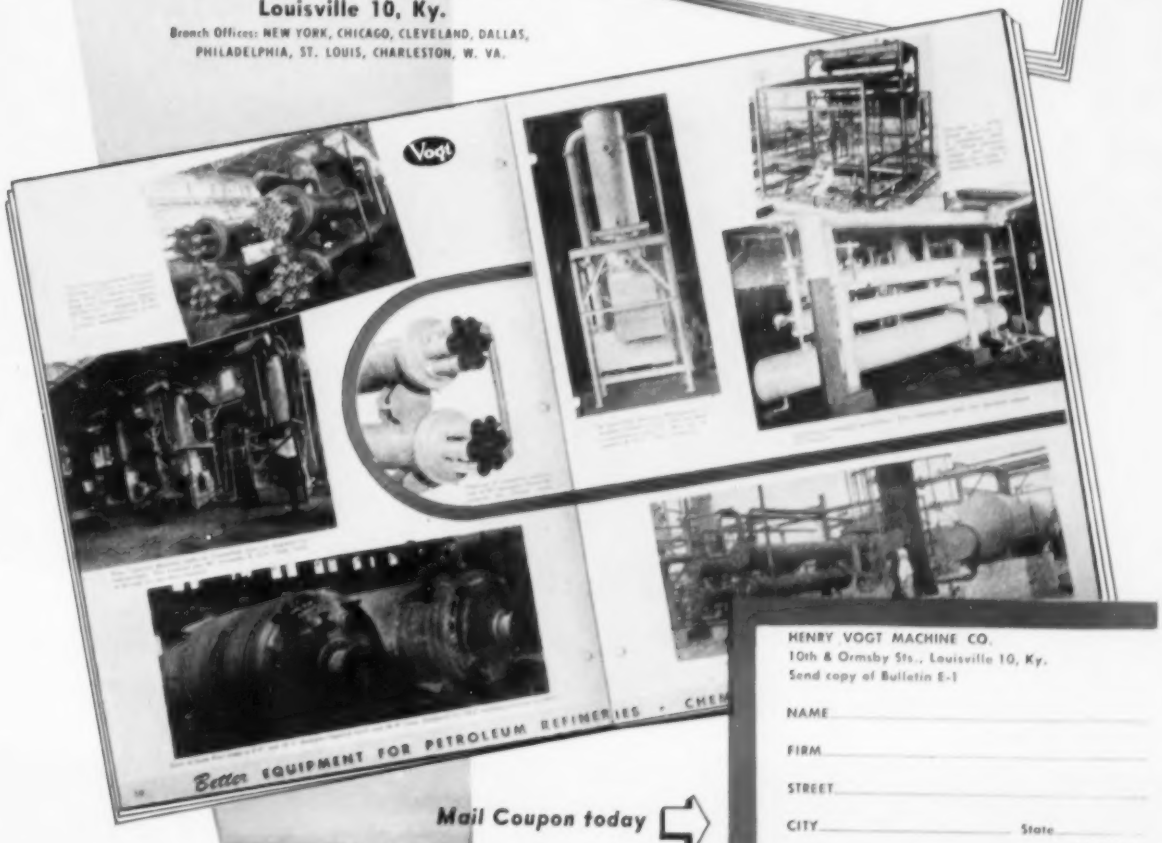

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"CLEAN HYDROGEN"

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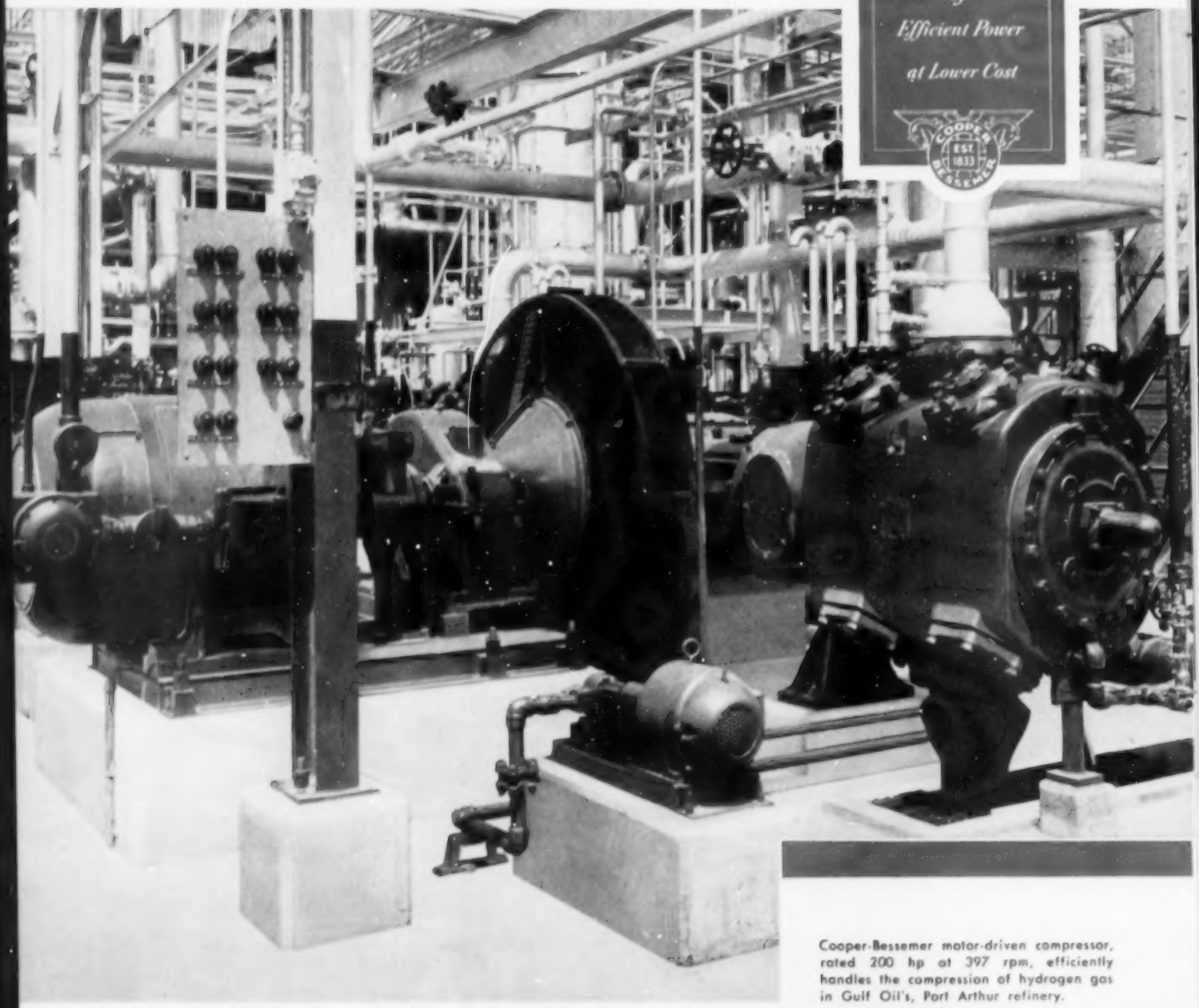
Another Example of Efficient Power at Lower Cost



Cooper-Bessemer motor-driven compressor, rated 200 hp at 397 rpm, efficiently handles the compression of hydrogen gas in Gulf Oil's, Port Arthur refinery.

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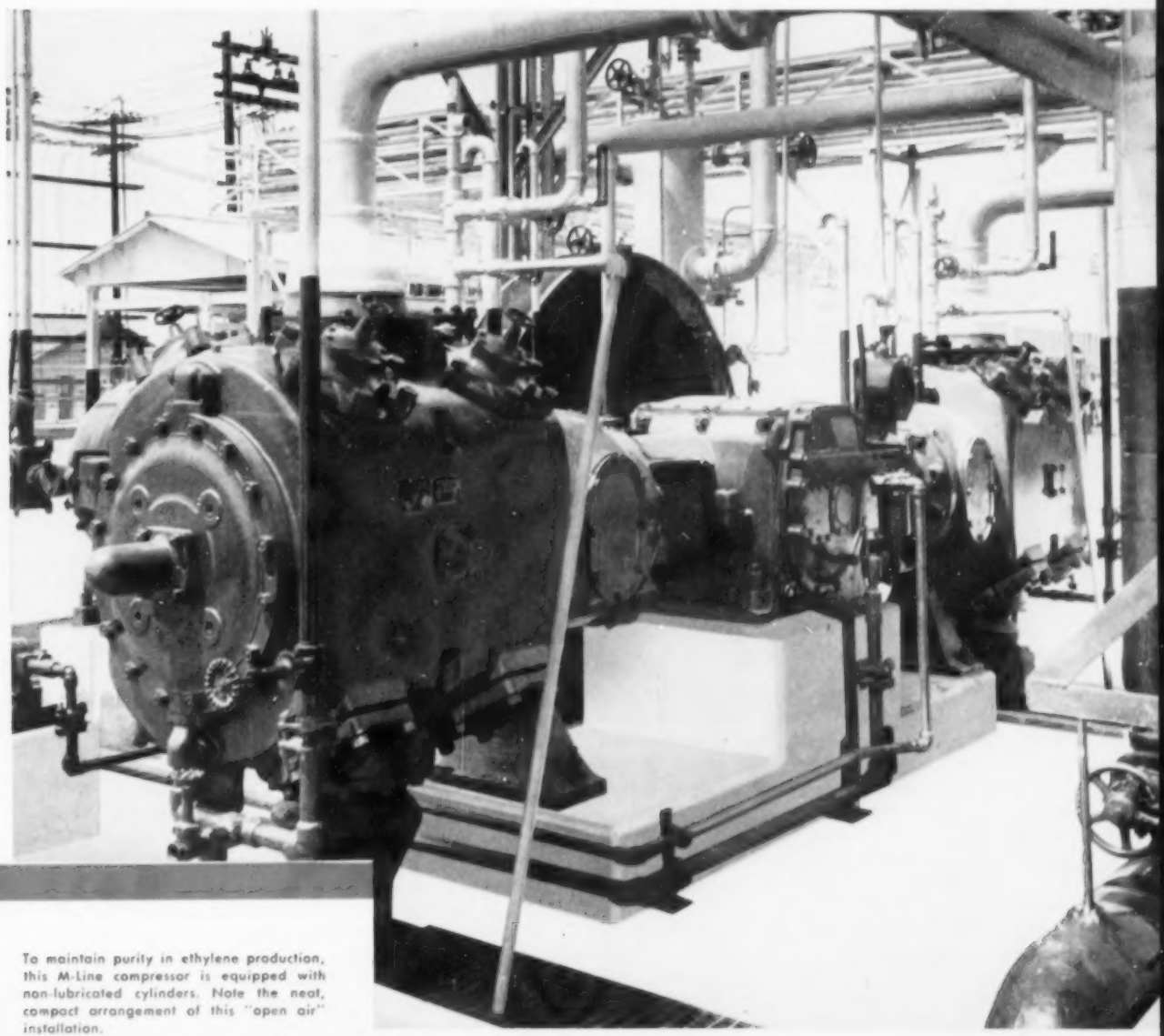
• In the Port Arthur, Texas, refinery of Gulf Oil Corporation, non-lubricated cylinders in a 200 hp Cooper-Bessemer compressor prevent any trace of oil from entering the gas stream. What could be more simple . . . eliminate lubricating oil and you eliminate any possibility of contaminating the process.

These perfected cylinders offer the same trouble-free service that has long been standard when Cooper-Bessemer compressors are on the job. Operating against micro-smooth, hardened cylinder liners, 22½" diameter aluminum pistons with carbon rings require no lubrication whatever.

For high efficiency regardless of pressure or volume, for compactness, and low maintenance, Cooper-Bessemer, as usual, offers the best return on your investment dollar. Write The Cooper-Bessemer Corporation, Mount Vernon, Ohio, for additional information.



To maintain purity in ethylene production, this M-Line compressor is equipped with non-lubricated cylinders. Note the neat, compact arrangement of this "open air" installation.

by **Cooper-Bessemer**

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THE SHORTAGE OF SCIENTISTS AND ENGINEERS:

What Can Be Done About It?

There is no easy or quick way to overcome the shortage of scientists and engineers that has become a threat to our national security and economic progress. The solution can come only through diligent efforts extending over several years to bring the supply of technically trained people into balance with our needs. Meanwhile, the pressure of the shortage can be relieved if industry, government and education make better use of the limited number of scientists and engineers now available.

Earlier editorials in this series have discussed the dimensions of the shortage of technical manpower, its meaning for our national security and our economic well-being and the causes of the shortage. This final editorial will survey some of the measures that can be taken to overcome the shortage. Most of the proposals presented here have been suggested elsewhere. But in combination they appear to offer the best hope of an answer to this serious national problem.

Soviet Methods Not For U. S.

It is clear that no crash program, inspired by panic and designed indiscriminately to drive hordes of high school students into science and engineering, is suitable for the United States. Even if we adopted Soviet methods of channeling a large portion of our brightest young people into technical fields, it would be at least four years before results appeared in the volume of college graduates. And such an approach would do no credit to the American way of life.

Any crash program, whether it involved totalitarian methods or simply overselling the advantages of technical careers, would be objectionable for other reasons as well. It would jeopardize the quality of scientific and engineering training. It would put many young people in fields where they have little aptitude and deny them to other fields for which they are better equipped. And, if carried too far, it might even result in the overcrowding that was feared prematurely a few years ago.

The most important problems for the long run, as the preceding editorial in this series indicated, are in the area of education. Any real solution must reduce the loss of talented high school graduates who do not continue their education for financial reasons or because of lack of interest. Also, it must improve the quality of high school preparation in science and mathematics and, above all, relieve the critical shortage of teachers.

Basic Needs in Education

Substantial increases in salaries of teachers in most of the nation's school systems are essential if high school students are to receive adequate preparation for courses in science and engineering. Pay scales that have lagged behind rising living costs and salaries available in industry have placed great strain on even the most devoted teachers. There has been a sharp drop in the number of new graduates trained to teach science and mathematics, and of this smaller number many have decided not to follow careers in teaching.

Raising teachers' salaries to more realistic levels must be primarily the job of local school districts, aided by state governments. If, in face of rapid increases in school enrollments, local and state resources prove insufficient, then federal aid will have to be considered. Higher teachers' salaries, however financed, inevitably mean higher taxes. But without appreciable improvement soon, the quality of our entire educational system is in danger.

At the college level also, financial aid is needed to provide scholarships for promising students and to increase faculty salaries. (An earlier series of editorials dealt more fully with these problems, and business aid to higher educational institutions has been mounting at a gratifying rate.)

But not all the educational problems related to the shortage of scientists and engineers can be solved with money. Science and mathematics have steadily been de-emphasized as more youngsters have gone to high school for terminal education rather

How business is helping to relieve the shortage of technical manpower

Summary of a Survey by McGraw-Hill Correspondents

- Sponsoring summer study programs for high school teachers
- Arranging cooperative work-and-study programs for students
- Sponsoring college fellowships and scholarships in science and engineering
- Paying tuition of employees taking science and engineering courses
- Keeping college faculties abreast of new developments in industry
- Hiring high school science teachers for summer and part-time work
- Giving old, but usable, laboratory equipment to schools
- Cooperating in high school science exhibits
- Sponsoring regional science fairs
- Sending speakers and training aids to schools
- Opening plants for student tours
- Analyzing jobs to relieve engineers and scientists of routine work

The McGraw-Hill Department of Economics will be glad to hear of any other ways business is helping relieve the shortage.

than for college preparation. This de-emphasis must be reversed.

Techniques of instruction, furthermore, can stand improvement at all levels of education. Professor E. P. Northrup of the University of Chicago observes: "In the past fifty years . . . there has been a revolutionary change in the character of mathematics, yet not a trace of this change is to be found in the curricula of all but a handful of secondary schools throughout the country." Colleges and universities may have to examine old fetishes about light teaching loads and small classes in order to make more efficient use of their faculties.

What Industry Can Do

Industry has the immediate problem of better utilization of available technical manpower and the long-range responsibility of helping increase our resources of trained people. Frantic recruiting practices and reckless bidding up of starting salaries—financed largely by government money for defense orders — are not the answer. There is need for earnest consideration of incentives for experienced scientists and engineers, who too often must look to sales or executive positions for adequate financial recognition.

Industry in many instances could make more efficient use of engineers and scientists by shifting work to technicians, clerical personnel and even machines. One company found that 15% of the time of an engineering design group was spent on routine jobs and that this valuable time could be saved by adding a technician and a clerical worker to the group.

Other potential sources of technical manpower could be tapped more extensively to relieve the shortage. Very few women have entered what has been traditionally a man's world. Negroes are only slowly gaining educational and employment opportunities in technical fields. And many experienced older men can still give useful service.

A Good Beginning

Much is being accomplished already in efforts to attract more young people into scientific and engineering careers. A summary of some of the things business is doing is presented above. Other notable contributions are being made by such organizations as the professional engineering and scientific societies (especially through their manpower commissions), the National Science Foundation, the National Research Council, the National Education Association, the National Merit Scholarship Foundation and the Thomas Alva Edison Foundation.

Results are beginning to appear in rising enrollments in engineering schools and technical institutes. Between 1951 and last year, according to McGraw-Hill's annual survey of technical institutes, enrollments in these schools rose from 46,000 to a record 67,000. Engineering enrollments rose in the same period from 166,000 to 243,000. A rising tide of graduates is already being made available to American industry.

This is a good beginning. But only with wider appreciation of the serious implications of the shortage of scientists and engineers and intensified efforts on the part of business, government and education to relieve the shortage can we hope to overcome this threat to our national security and economic well-being.

This is one of a series of editorials prepared by the McGraw-Hill Department of Economics to help increase public knowledge and understanding of important nationwide developments of particular concern to the business and professional community served by our industrial and technical publications.

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Donald C. McGraw

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A mass spectrometer in my laboratory?

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The 21-620 and 21-610, together with their accessory systems, work on either a batch or continuous-stream basis to permit . . . .

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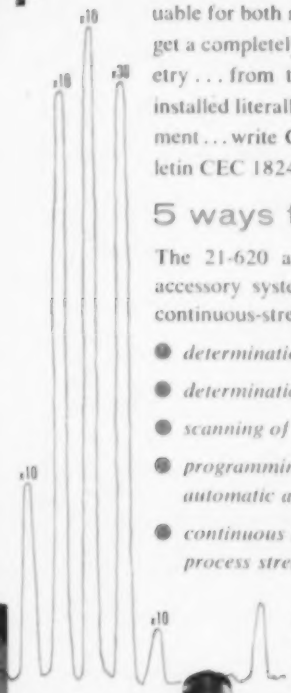

Typical record sections from a 21-620 analysis . . . peaks from mass 2 to mass 150 are easily read, well separated, quickly calculated.

Both the 21-610 and 21-620 Mass Spectrometers are flexible and simplified, need only 115 volts and a small supply of cooling water, are easily moved around the plant. The Type 21-610 is useful for monitoring streams with components to mass 80. The Type 21-620 employs the newly developed "Cycloidal Focusing" principle, is usable for accurate readings from mass 2 to mass 150.

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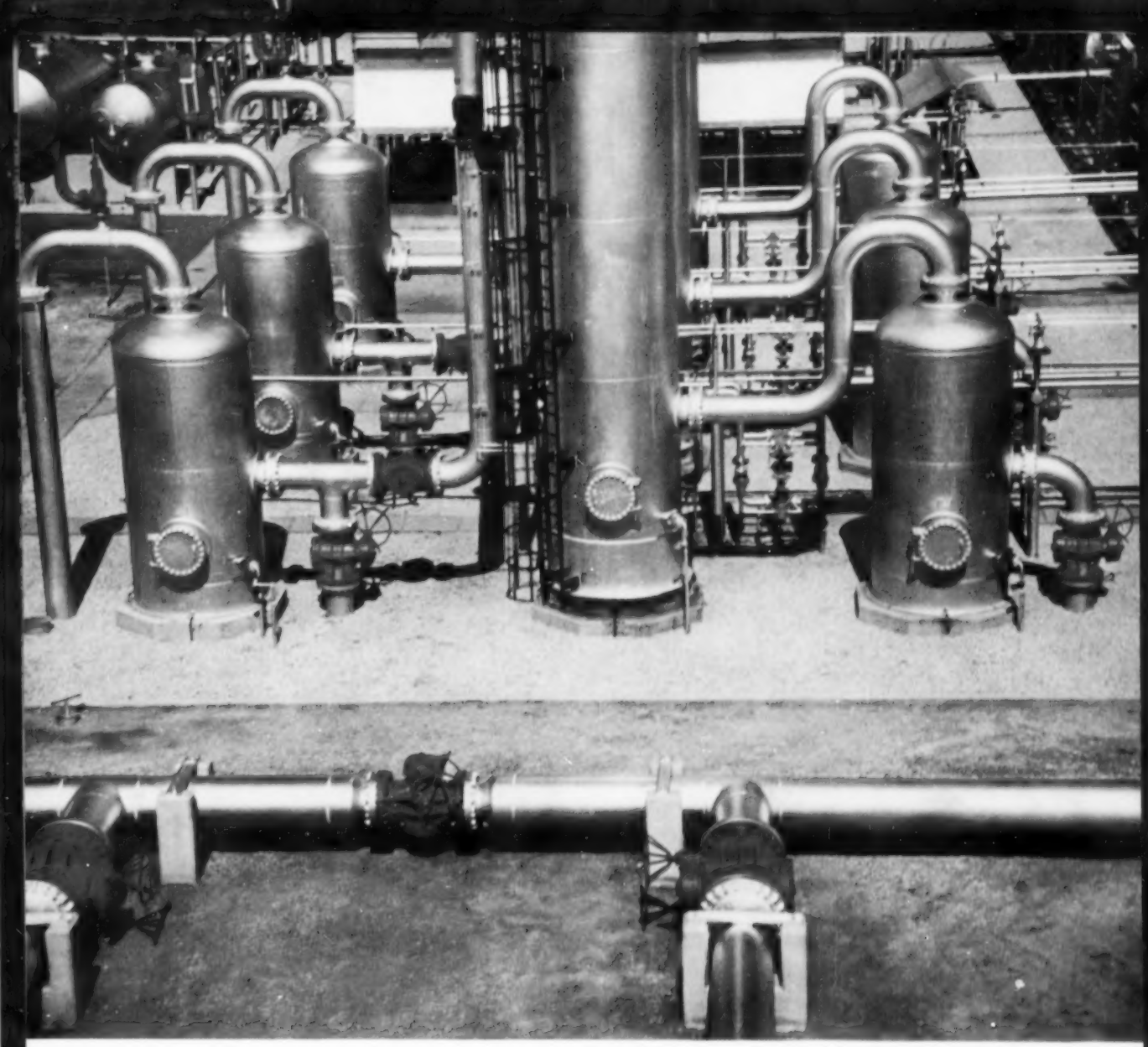

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You don't pay extra for the inherent safety of Rockwell-Nordstrom valves. Actually, their price is often lower than ordinary valves. Their cost to use, year after year, is much lower because lubricant stops trouble before it starts.

Forty years of outstanding performance have proven you can't buy a safer valve than Rockwell-Nordstrom. Pressurized lubricant sealing means positive, leakproof control on lightest gases. Streamlined thru-port design minimizes pressure loss on even heavy slurries. Quarter-turn operation is two to five times faster than ordinary valves. You *know* you are safe when you specify Rockwell-Nordstrom valves. Rockwell Manufacturing Company, Pittsburgh 8, Pennsylvania.

Available at leading suppliers . . . everywhere.

ROCKWELL-Nordstrom **VALVES**

Lubricant Sealed for Positive Shut-off

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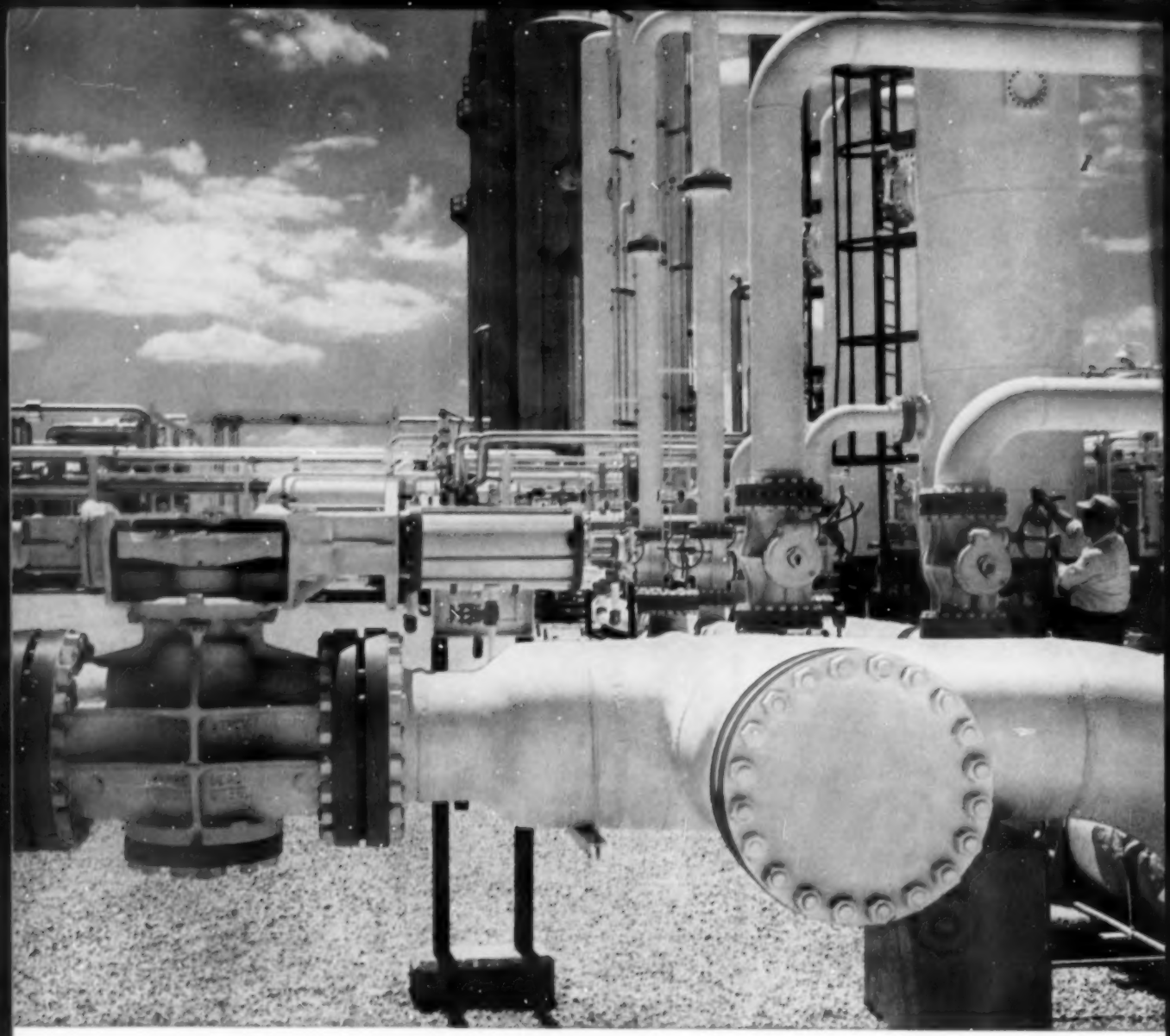

For power operation . . . clearly superior

Rockwell-Nordstrom valves' quarter-turn operation allows the use of less complicated (and less costly) operators. Lubrication greatly reduces torque. The thin, tough film of *pressurized* lubricant that forms the leakproof seal also cuts maintenance and down time by stopping trouble before it starts.

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BAKER TRAVELOADER picks up loads from the side, carries them lengthwise—safely aboard the truck deck, and stacks them from the side to a height of 12 feet. This makes it the ideal truck for yard handling of pipe or any other long, unwieldy loads. It can operate in 10 ft. aisles, over paved and unpaved roadways—with travel speeds up to 30 MPH.

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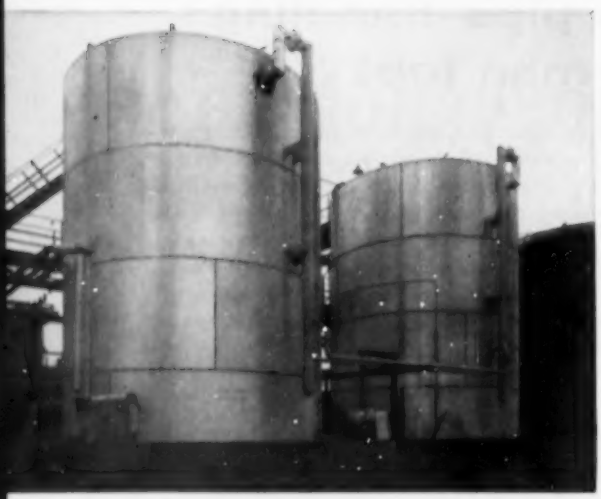
Reflux condensers for soap neutralization, made from ⅛"-thick type 304 Stainless.

Not a Single Stainless Steel failure

in equipment for handling finished detergents



Synthetic detergent tanks (Stainless) have been in service for four years and are still as good as new. Previous coated tanks lasted 18-24 months.

The Atlantic Refining Company's Philadelphia refinery produces detergents as one of the derivatives.

Product contamination was the big problem. They tried sprayed-on plastic and phenolic coatings, but they all failed. Since they installed Stainless Steel, there has not been a single failure in the finished product handling equipment. There has been no corrosion problem. No contamination.

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TYPICAL CHEMICAL ANALYSES (%'s)

	LOW SURFACE AREA	INTERMEDIATE SURFACE AREA
Al_2O_3	89.4–76.6	77.0
SiO_2	9.3–16.8	21.2
Fe_2O_3	0.5 – 1.3	0.2
MgO	0.1 – 0.6	0.4
CaO	0.1 – 0.8	
Na_2O	0.3 – 0.4	0.5
K_2O	0.1 – 1.0	0.2
TiO_2	0.2 – 2.5	0.5

PHYSICAL PROPERTIES

	Porosity	Water Absorption	Bulk Density	Vol. Bulk Density	Crystal Structure	Surface Area
Low Surface Area	40-50%	20-25%	1.90-2.10 gr/cc	65-80 lbs/ft³	Alpha Alumina	Less than 1m²/gram
Intermediate Surface Area Type A	50-55%	28-30%	1.65-1.70 gr/cc	58 lbs/ft³ (app)	Alpha, Gamma Alumina-chiefly Gamma	60-70m²/gram
Type B	50-55%	28-30%	1.65-1.70 gr/cc	60 lbs/ft³ (app)	Quartz, Alpha, Kappa, Delta Alumina-	20-30m²/gram
Type C	50-55%	28-30%	1.65-1.70 gr/cc	62 lbs/ft³ (app)	Alpha Alumina and Mullite	5-10m²/gram

Shapes and Sizes

Spheres: (Low surface area) 3/16"-1" diam; (Intermediate surface area) 1/4"-1/2" diam. *Pellets:* (All carriers) 1/8" x 1/8"-1/2" x 1/2". *Rings:* (All carriers) 1/8" x 1/4" x 3/8" O.D.-1" x 1 1/2" x 1 1/2" O.D.

Typical Applications

Low Surface Area Carriers: phthalic anhydride, maleic anhydride, ethylene oxide, protective atmospheres, synthetic gas generation, grates or suspending beds for active catalysts.

Intermediate Surface Area Carriers: catalytic reforming, dehydrogenation, dehydration, sulfuric acid manufacture, nitric acid manufacture, dessicants.

Get More Facts

on how Norton ALUNDUM catalyst carriers are *engineered and prescribed* to give you the most effective combination of physical, thermal, chemical and electrical properties. Learn how they can improve and economize your processing. Call in your Norton Refractories Engineer, or write, mentioning your specific requirements, to NORTON COMPANY, 270 New Bond St., Worcester 6, Mass. *Canadian Representative:* A. P. Green Fire Brick Co., Ltd., Toronto, Canada.

NORTON
REFRACTORIES
Engineered... Rx ... Prescribed
Making better products... to make your products better

*Trade Mark Reg. U. S. Pat. Off. and Foreign Countries

. . . there's enough difference to make ALL the difference

Every single finished Scovill Heat Exchanger Tube is subjected to a 1,000-lb. hydrostatic pressure test and an 80-lb. air pressure test under the eyes of experienced inspectors. Very seldom does a tube fail at this point; yet this and other final inspections for tube perfection are always rigidly maintained.

Before Scovill Heat Exchanger Tubes reach these final inspection benches, specialized production methods and controls have already assured their inherent uniformity in alloy composition . . . with soundness in metal structure . . . and dense, smooth surfaces, free from defects. Scovill safeguards assure delivery to customers of tubes in top physical condition . . . an essential to dependable heat exchanger service.

Scovill Technical Service stands ready to help you select the correct tube alloys for your applications, with recommendations based on most comprehensive experience records.

Scovill Manufacturing Company, Mill Products Division,
99 Mill Street, Waterbury 20, Connecticut. Phone: Plaza 4-1171.

SCOVILL **HEAT EXCHANGER TUBE**

FOR APPLICATIONS FROM MARINE TO PETROCHEMICAL . . . FROM COMPRESSOR INTERCOOLERS TO "CAT-CRACKER" EXCHANGERS.

Phosphorized Admiralty • Admiralty • Arsenical Admiralty • Naval Brass • Red Brass, 85% • Deoxidized Copper
Arsenical Copper • Cupro Nickel 10%-20%-30% • Aluminum Brass • Aluminum Bronze, 5% • Muntz Metal • Duplex Tube

119C84

 (To obtain more data on advertised products see page 182)

This is your Guarantee . . .

...OF THE BEST FLOATING ROOF MONEY CAN BUY!

The name plate above tells more than just a few cold facts. Affixed to all Horton® Floating Roofs, it is your assurance of the best roof your money can buy!

Note the UL symbol in the center . . . Underwriters Laboratories, Inc., symbol of approved devices. Horton Floating Roofs have been examined and tested for practicability, durability, strength and fire retardant features by this well known organization.

Write our nearest office for complete information on Horton Floating Roofs . . . Double-Deck, Pontoon or Pan . . . and be sure to ask for a copy of the Underwriters Laboratories report too.

Top: Name plate from storage tank equipped with Horton Floating Roof.

Bottom: Two 80,000-bbl. tanks equipped with Horton Double-Deck Floating Roofs at Edmonds, Washington, refinery of Union Oil Company of California.

CBI

Chicago Bridge & Iron Company

Atlanta • Birmingham • Boston • Chicago • Cleveland • Detroit • Houston
Los Angeles • New York • Philadelphia • Pittsburgh • Salt Lake City
San Francisco • Seattle • Tulsa
Plants in BIRMINGHAM, CHICAGO, SALT LAKE CITY and GREENVILLE, PA.
REPRESENTATIVES AND LICENSEES:
Brazil • Canada • England • France • Italy • Netherlands • Scotland • Venezuela

Bingham STUFFINGBOXLESS PUMPS

HANDLE AT HIGH

FIREPROOF AND EXPLOSION-PROOF! Leakage of vapor or liquid to atmosphere or leakage from outside into pump is *impossible*. Not only is plant and personnel protected but loss of valuable pumpage is prevented. Type KC High-Pressure Single-Stage Stuffingboxless Pump illustrated.

NO STUFFING BOX! NO PACKING!

Bingham Stuffingboxless Pumps are successfully handling liquids having high vapor pressure, requiring high suction pressure and, frequently, abnormally low pumping temperature (—300° F). Standard models handle suction pressures up to 2,000 psi (higher pressures available). Pumping temperatures to 850° F and higher also can be handled. These conditions present no difficulty for Bingham Stuffingboxless Pumps, but they are difficult and sometimes impossible to meet with conventional pumps due to limitations imposed by the stuffing box.

Because there is *no stuffing box*, Bingham Stuffingboxless Pumps eliminate all the disadvantages of conventional pumps operating with stuffing boxes equipped with packing or mechanical seals.

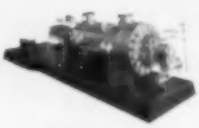
Bingham Stuffingboxless Pumps are in service today all over the world, with distinguished records in reliability, continuity of service, and low maintenance. Write to your nearest Bingham office for Bulletin 107 or for additional information.

***And other volatile liquids.**

TYPICAL BINGHAM "DOUBLE VOLUTE"

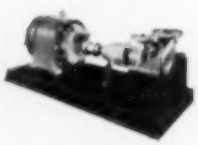
The Bingham Type HPD "Double Volute" Multi-Stage Double Case "Hi-Press" pump for extremely high pressure service.

Bingham Type VS Single-Stage Wet-Pit Pump for high capacity, medium head service.



Bingham Type CP "Double Volute" Multi-Stage, Double-Case pump for hot or cold service.

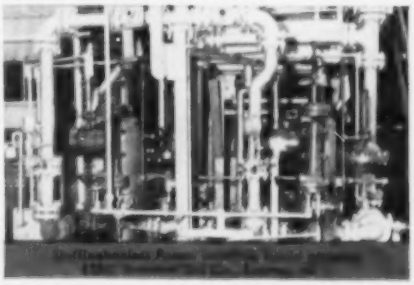
A Bingham Type CKA "Double Volute" Single-Stage Koke-Krusher for coke-laden pumpage.

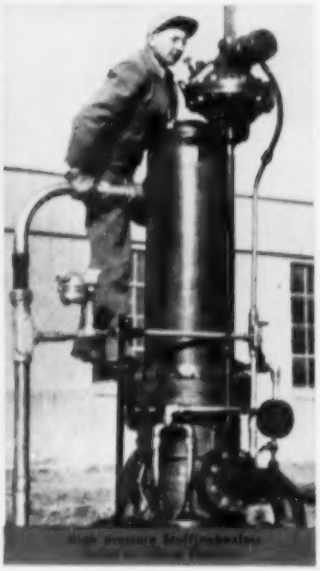


Bingham Type CAD "Double Volute" Single-Stage Process Pump.

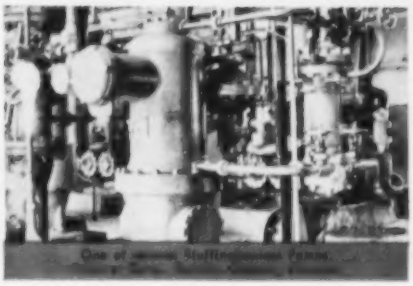
Bingham Type CJ "Double Volute" Two-Stage Process Pump.

LIGHT HYDROCARBONS* SUCTION PRESSURES





Unattended booster station on a major gathering system.



One of several Stuffingboxless Pumps.

High pressure Stuffingboxless Pump.

Partial List of Refineries Using Bingham Stuffingboxless Pumps

British American Oil Co., Ltd.
Carbide & Carbon Chemical Co.
Canadian Investors, Ltd.
Cities Service Company
Creole Pipe Line Company
E. I. duPont de Nemours & Co.
ESSO Standard Oil Co.
Great Lakes Pipe Line Co.
Gulf Oil Corp.
Imperial Oil Company Ltd.
Polymer Corporation
Phillips Petroleum Co.
Stanolind Oil & Gas Co.
Sinclair Oil Company
Sohio Petroleum Co.
Standard Oil Company of Indiana
Tennessee Gas & Transmission Co.
Tide Water Associated Oil Co.
Texas Company
Warren Petroleum Co.

Bingham SINCE 1921

DOUBLE VOLUTE PUMPS RADIAL BALANCE

BINGHAM PUMP COMPANY
General Offices: 2800 N.W. Front Avenue, Portland 10, Oregon
Factories: Portland, Ore. • Vancouver, B. C., Canada

SALES AND SERVICE OFFICES

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CHICAGO, ILL.
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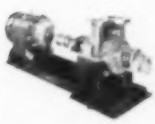
NEW ORLEANS, LA.
NEW YORK CITY, N.Y.
PHILADELPHIA, PA.
PITTSBURGH, PA.
SAN FRANCISCO, CALIF.
SEATTLE, WASH.
ST. LOUIS, MO.
ST. PAUL, MINN.
TULSA, OKLA.
TORONTO, ONT., CAN.
VANCOUVER, B. C., CAN.

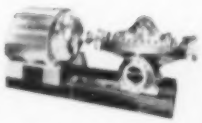
PUMPS FOR PETROCHEMICAL SERVICE



Bingham Type CD "Double Volute" Double Suction vertically-split case pump for hot service.

Bingham Type CM vertically split-case two-stage pump for hot service.

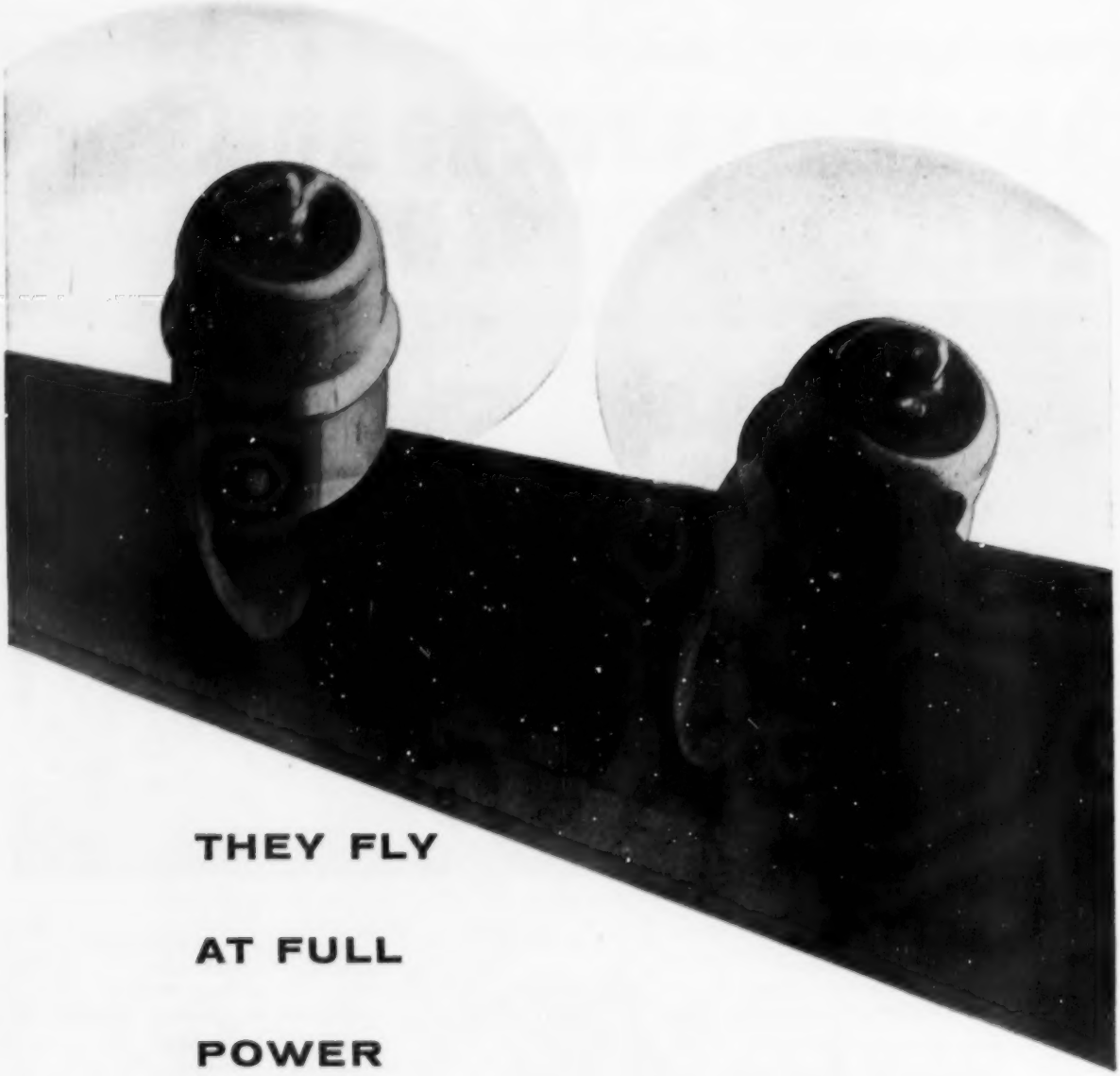
Bingham Type MSB Horizontally Split-Case Multi-Stage Pump for high pressure hot or cold service.



Bingham Type HSB "Double Volute" Double Suction Pump for high heads.

Bingham Type KT Stuffing-boxless Pump for high suction pressures and cold service.

Bingham Type VCP Vertical Pump for low NPSH conditions, featuring bottom dismantling.



THEY FLY AT FULL POWER WHEN GASOLINE CONTAINS

Tenamene

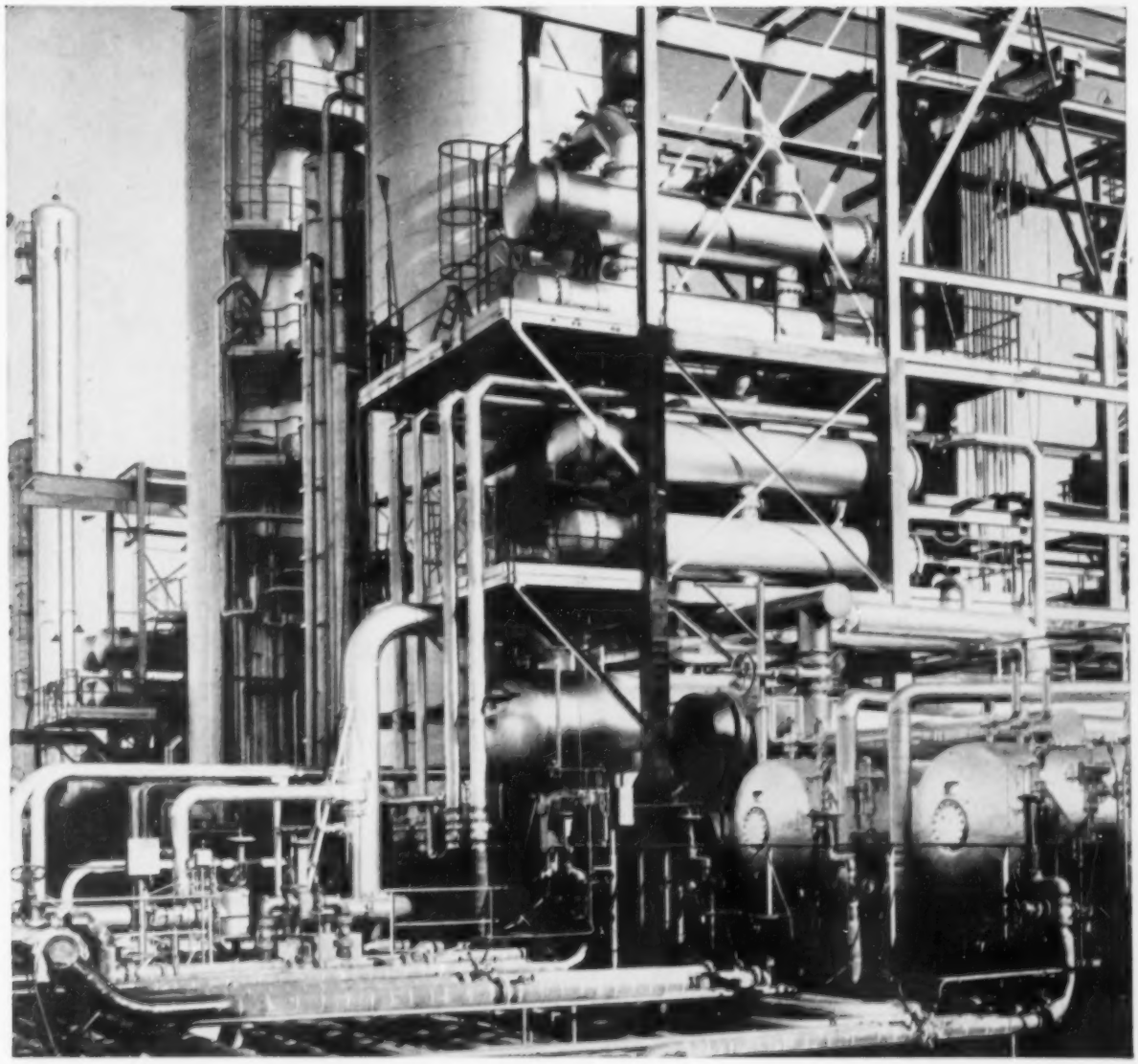
EASTMAN GASOLINE ADDITIVES

Protect the performance of the gasolines you produce. Tenamene inhibits gum formation, assuring engines of the full power you build into your fuels. An Eastman petroleum specialist is always available to assist you in achieving maximum performance from these dependable additives.

For more information on Tenamene additives and the service that backs up their proper use, contact our local representative or write to EASTMAN CHEMICAL PRODUCTS, INC., *subsidiary of Eastman Kodak Company,* KINGSPORT, TENNESSEE.

SALES OFFICES: Eastman Chemical Products, Inc., Kingsport, Tennessee; New York City; Framingham, Mass.; Cincinnati; Cleveland; Chicago; St. Louis; Houston. **West Coast: Wilson Meyer Co.,** San Francisco; Los Angeles; Portland; Salt Lake City; Seattle.

(To obtain more data on advertised products see page 182)



When temperatures and thruput go **UP**...

Carpenter Stainless Tubing holds corrosion costs **DOWN**

• Is the threat of rapid deterioration of tubing in heat exchangers and other process units keeping you from raising temperatures and increasing velocities?

Carpenter Stainless Tubing and Pipe have proven their ability to stand up under increased temperatures and thruput, with substantial cost reductions in material, labor and downtime.

Complete line of 14 standard AISI analyses and many other special alloy grades are available. Write for latest Selecting and Buying Guide . . . or contact your Carpenter Distributor now.

MEMBER

The Carpenter Steel Company
Alloy Tube Division, Union, N. J.

Export Dept.: The Carpenter Steel Co., Port Washington, N.Y.—"CARSTEELCO"

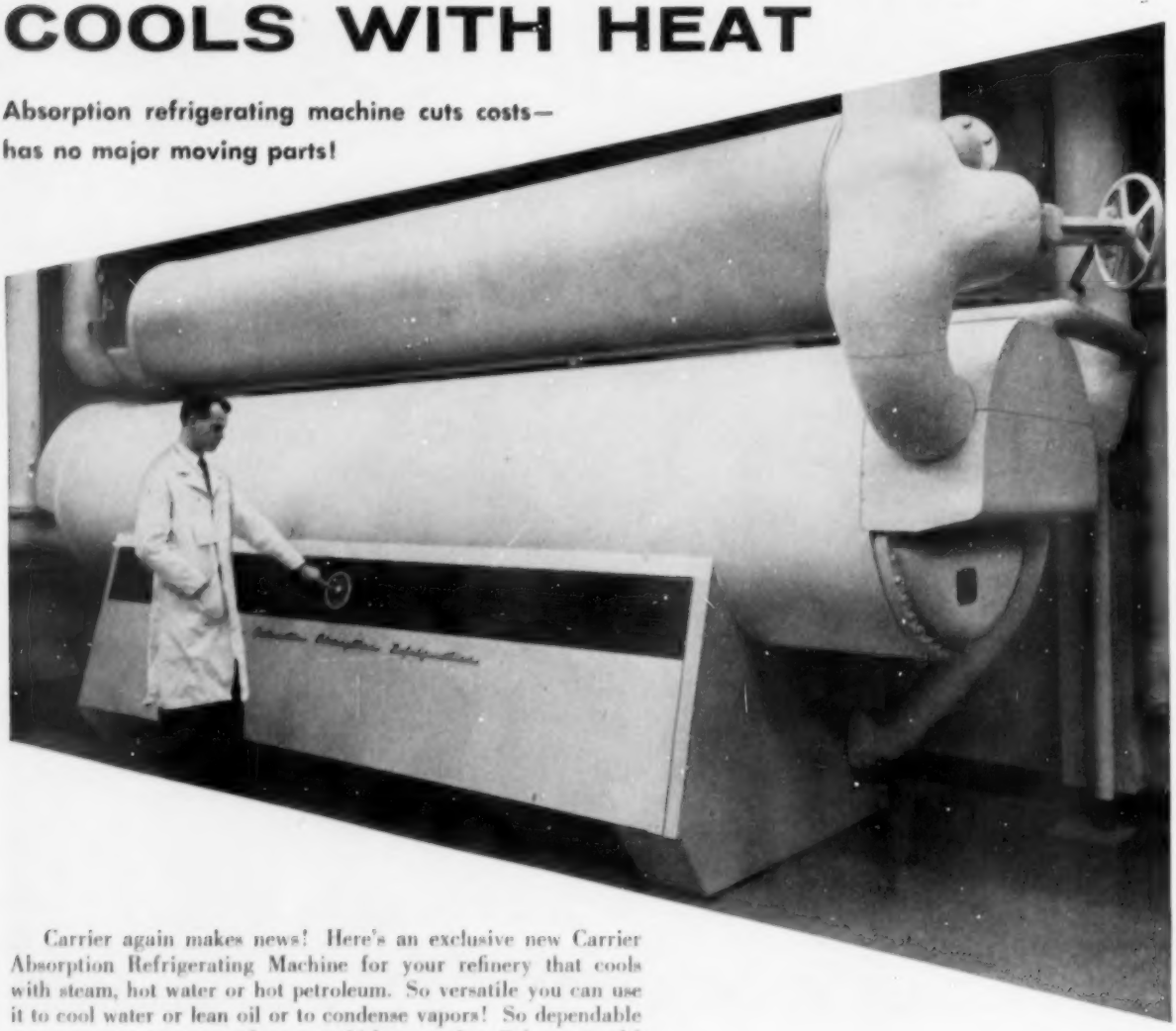
Carpenter

Stainless Tubing & Pipe

 (To obtain more data on advertised products see page 182)

Exclusive New Carrier Machine
COOLS WITH HEAT

Absorption refrigerating machine cuts costs—has no major moving parts!



Carrier again makes news! Here's an exclusive new Carrier Absorption Refrigerating Machine for your refinery that cools with steam, hot water or hot petroleum. So versatile you can use it to cool water or lean oil or to condense vapors! So dependable you can count on top performance 24 hours a day, 7 days a week!

Low-cost cooling? You can get it with Carrier absorption refrigeration! Waste steam or hot liquids from other processes in your refinery are the energy source. Electricity is used only for small pumps and controls—there are no major moving parts!

Automatic operation? You can get it with Carrier absorption refrigeration! You push a single button to start the machine, push that same button again to stop it. No highly trained operator is needed. Electronic controls do all the "thinking."

A machine that follows cooling needs to *zero capacity*? You can get it with Carrier absorption refrigeration! It's the only refrigerating equipment that will operate in a completely automatic cycle from 100% full load down to zero capacity without expensive controls, and do it with a perfectly smooth operating curve.

And you get still other advantages from Carrier absorption refrigeration. Light weight. Compact design. Simple maintenance. A wide range of capacities—100 to 700 tons of cooling.

Get the full story. Call your nearest Carrier office for your copy of a new 36-page booklet on Carrier Absorption Refrigerating Machines. Or write Carrier Corporation, Syracuse, New York.

Carrier

centrifugal compressors

refrigerating equipment

(To obtain more data on advertised products see page 182)

NOW!

A BRAND-NEW CONCEPT IN FLOW TOTALIZING!

. . . THE NEW FOXBORO PNEUMATIC FLYBALL INTEGRATOR

Inherently Accurate!

- Eliminates Inaccurate "Spot Check" Counting!
  Continuous integration assures highest precision.
- Eliminates Cam and Linkage Errors!
  Unique design balances differential pressure signal directly against centrifugal force.
- Eliminates Calculations!
  Automatically extracts square root — shows totals in desired units.
- Eliminates Fire and Explosion Hazards!
  Simple, all-pneumatic operation requires no electric motors, wires, or contacts.

FOXBORO
REG. U. S. PAT. OFF.

Now you can integrate the flow of all process fluids or plant services *continuously* . . . with new accuracy . . . complete safety! The unique new, all-pneumatic Foxboro Flyball Integrator completely eliminates intermittent counting and fire hazard. Its simple, force-balance operation utilizes the 3-15 psi air signal from any differential-pressure flow transmitter. This signal is *continuously* balanced against the "flyball" force of the instrument's pneumatically-driven turbine. The square root function is automatically extracted . . . you read flow totals *directly*.

The Flyball Integrator mounts at the point of measurement or on a panel hundreds of feet away. Response and accuracy are completely unaffected by ambient temperature changes or pressure changes in turbine air supply. Ideal solution to all plant fluids accounting and in-process inventory checking. Write for complete details. The Foxboro Company, 9111 Neponset Ave., Foxboro, Mass.

FIRST IN FLOW

New Copper Deactivator Guaranteed not to freeze!

This special all-weather UOP Copper Deactivator formulation will not freeze when stored for extended periods at temperatures down to 0° F. We call it Copper Deactivator-AW(50)*, since it contains active ingredient in 50% concentration. This new formulation completely eliminates the low temperature pumping problems common to other deactivators.

AW(50) gives maximum metal deactivating efficiency and economy. Improved color, too, and because of its better solubility and pumping properties, it can be injected directly into gasoline or other refinery streams without the customary dilution with aromatic spirits.

AW(50) is supplied in handy five-gallon containers for manual addition or blending with other additives and in 55-gallon drums for automatic injection systems.

*Trademark of Universal Oil Products Company

PRODUCTS DEPARTMENT

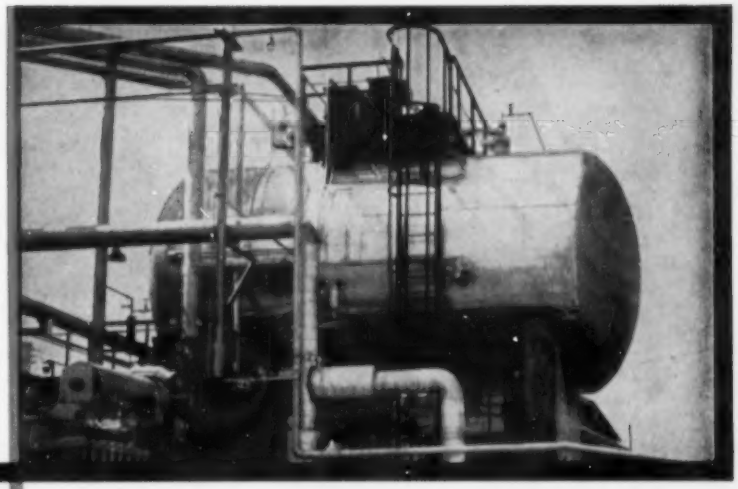
UOP

UNIVERSAL OIL PRODUCTS COMPANY

30 ALGONQUIN ROAD, DES PLAINES, ILLINOIS, U. S. A.

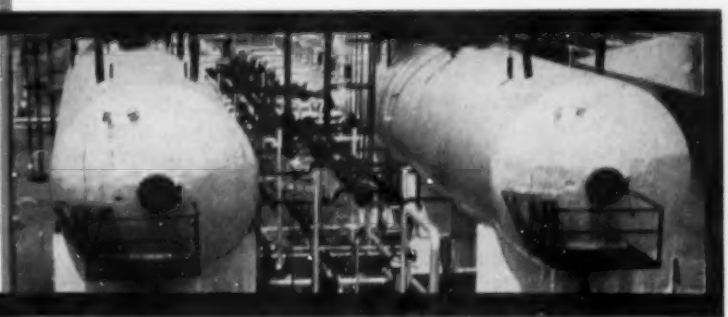
(To obtain more data on advertised products see page 182)

HOW TO SOLVE A SALT PROBLEM



+ ADD	A PETRECO Electric Desalter to your crude processing equipment. It will
− SUBTRACT	the salts, fines and other impurities from your crude charge, enabling you to
÷ DIVIDE	your lost time on stream and maintenance costs by 2 or 3 and
× MULTIPLY	your total unit throughput and refining profits.

Petreco pioneered electric desalting and has originated the major developments since its beginning. No other method offers a superior technical service staff, backed by so many years of desalting experience. Petreco electric desalting is used by more refiners than any other method.



SPECIALIZED ELECTRIC PETROLEUM TREATING

Desalting • Dehydrating • Caustic Washing • Acid Contacting • Heater Treating • Sweetening • Naphthenate Acid Removal • Sulfonate Removal

FOR COMPLETE INFORMATION, WRITE OR CALL

PETRECO

A DIVISION OF PETROLITE CORPORATION

3202 S. Wayside Drive, Houston 1, Texas
1390 East Burnett St., Long Beach 7, California

DS 6-4

GIANT

TIDEWATER REFINERY

PROTECTED

by Consolidated Safety Relief Valves

FLYING A SERVICE

The world's most modern refinery will soon go on stream. It is the gigantic Delaware Flying A Refinery of the Tidewater Oil Company just 15 miles south of Wilmington. C. F. Braun & Co., engineering contractors, built the new plant on the 5000-acre site. Many of the processing units are unequalled for size and capacity anywhere. In around-the-clock operation, 130,000 barrels of crude of any kind can be processed daily. Tidewater engineers incorporated the most advanced design and equipment to provide the greatest flexibility, economy and safety.

Consolidated Safety Relief Valves are "sentinels of safety" in this mammoth "refinery of the future". Peak performance and consistently positive valve action are assured even where discharge lines are long or there is low "superimposed" back pressure in the relieving system. They provide the absolute protection so vital in petroleum processing and on product storage facilities.

Wherever Consolidated Safety Relief Valves are used, flexibility of application greatly reduces inventory costs. They are "2 in 1" valves. Interchangeability is so highly perfected that you can convert the Standard type to the Balanced Bellows Seal type *in the field* simply by installing a stainless steel sealing bellows. You can readily interchange these valves with those of other manufacturers: inlet and outlet center-to-face dimensions are standardized. Consolidated Safety Relief Valves also have fewer functional parts than comparable valves. The seating surface is optically-ground flat. From every standpoint, you can count on lower inventory costs and easy maintenance.

Write for full details about the complete reliability and all-around economy of Consolidated Safety Relief Valves. Both Standard and Bellows type are available in sizes and pressures to meet requirements today and tomorrow. Ask for Catalog 1900.

CONSOLIDATED SAFETY RELIEF VALVES

CERTIFIED AND APPROVED. Both Standard and Bellows Valves are approved under API-ASME and ASME Unfired Pressure Vessel Codes and are certified by the National Board of Boiler and Pressure Vessel Inspectors.

Tidewater Oil Company's "refinery of the future" has required nearly 7000 men in its construction. The enormous size of the installation can be gauged by the 500-foot high power station stack at the extreme left. To the right of the stack are, in order, the fluid coker, the sulphur recovery plant, the crude unit, the Orthoflow fluid catalytic cracker and other processing units. The Delaware Flying A Refinery's 7,000,000 barrel capacity "tank farm" is in the background. The refinery's processing units occupy 450 acres of the 5,000-acre site.

The Orthoflow catalytic cracker—the world's largest, with a daily capacity of 102,000 barrels—is equipped with Consolidated Safety Relief Valves.

Consolidated Safety Relief Valves also stand guard atop the propane storage bullets at Tidewater's Delaware Flying A Refinery.

A PRODUCT OF **MANNING, MAXWELL & MOORE, INC.**

TULSA, OKLAHOMA

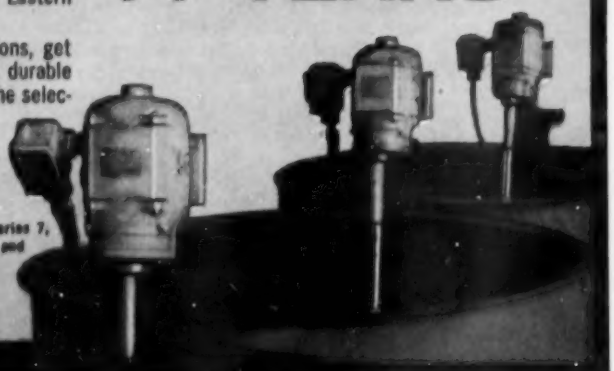
MAKERS OF 'AMERICAN' INDUSTRIAL INSTRUMENTS, 'ASHCROFT' GAUGES, 'CONSOLIDATED' SAFETY AND RELIEF VALVES, 'AMERICAN-MICROSEN' INDUSTRIAL ELECTRONIC INSTRUMENTS, *Stratford, Conn.*, 'HANCOCK' VALVES, *Watertown, Mass.*, 'CONSOLIDATED' SAFETY RELIEF VALVES, *Tulsa, Okla.*, AIRCRAFT CONTROL PRODUCTS, *Danbury & Stratford, Conn. and Inglewood, Calif.*, "SHAW-BOX" AND 'LOAD LIFTER' HOISTS AND OTHER LIFTING SPECIALTIES, *Muskegon, Mich.* **In Canada:** *Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario.*

Back in 1942 the new synthetic rubber program was of urgent importance to the war effort. Naugatuck Chemical Company, Division of U.S. Rubber Co., developed processes that included fluid mixing applications. Many of Naugatuck's top-entering and portable mixers were engineered and manufactured by Eastern Industries specifically for these processes.

After fourteen years of hard, continuous service, these Eastern Mixers continue proving their built-in **reliability.**

If you have a process entailing critical operating conditions, get a long-term guarantee on your investment by selecting durable Eastern Mixers. Eastern offers engineering assistance in the selection of proper mixers from the complete Eastern line.

CONTINUOUS SERVICE . . . 14 YEARS



Eastern INDUSTRIES, INC.
Mixer Division
Regent Street
Norwalk, Conn.

Write for Catalog Series 7, containing product and engineering data.

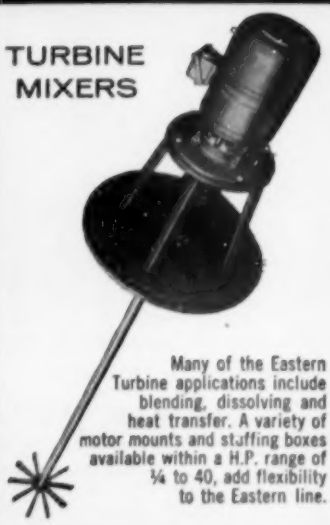
PORTABLE MIXERS

Various models offer a choice of speeds and H.P. dependent upon the consistencies of fluids. All models are available with shafts and propellers of various alloys. Single and dual propellers, and a wide choice of motors give flexibility to handle the most critical of operating conditions.

TOP & SIDE ENTERING MIXERS

Heavy-duty models cover the range from ¼ to 30 H.P., at speeds from 280 to 1725 R.P.M. Versatile in design . . . rugged in performance, these mixers offer a wide choice in mounting arrangements and motors. All side entering models are available with stuffing boxes which can be repacked with a full tank.

TURBINE MIXERS



Many of the Eastern Turbine applications include blending, dissolving and heat transfer. A variety of motor mounts and stuffing boxes available within a H.P. range of ¼ to 40, add flexibility to the Eastern line.

DU PONT
REG. U.S. PAT. OFF.

PETROLEUM CHEMICALS DIVISION

NEWS

DU PONT
REG. U.S. PAT. OFF.

November ★ One of a Series of Bulletins for the Petroleum Industry ★ 1956

Du Pont uses sports car to study fuel-injection related to product development

Although sports cars are designed for road racing or as a highway hobby, the Du Pont Petroleum Laboratory is now using one for an entirely different purpose.

With an eye to future automotive fuel requirements, the laboratory is now fitting out a new Mercedes-Benz, 300 SL, with special instrumentation. The objective is to investigate the additive needs of fuels for fuel-injection engines and to test promising candidates under actual road conditions. The Mercedes-Benz was picked for this work because it is the only car with a fuel-injection engine that is commercially available in this country.

Mercaptide problems solved with DMD

If you are not now using Du Pont Metal Deactivator in your heating and diesel fuels, we believe you will be interested in the success of other refiners who have used it.

Several years ago, for example, a major oil company was having copper mercaptide problems. They encountered the trouble in both straight-run diesel fuel and No. 2 fuel oil composed of 95% straight-run and 5% Houdry cat-cracked.

To solve the problem, 2 pounds of DMD per 1,000 barrels were added to both fuels. This proved highly successful for several seasons. Then the use of DMD was discontinued. The trouble recurred. So DMD was again added, and this company's mercaptide problem was again under control.

Another major company encountered gel-clogging complaints in the Spring of 1955. The trouble involved a No. 2 fuel oil composed of fluid cat-cracked and straight-run. The cracked component varied in composition from 75% to 90%.

During the next heating season, the company added 2 pounds of DMD (in combination with Du Pont Fuel Oil Additive No. 2) per 1,000 barrels. There were no complaints of mercaptide formation reported the following season.

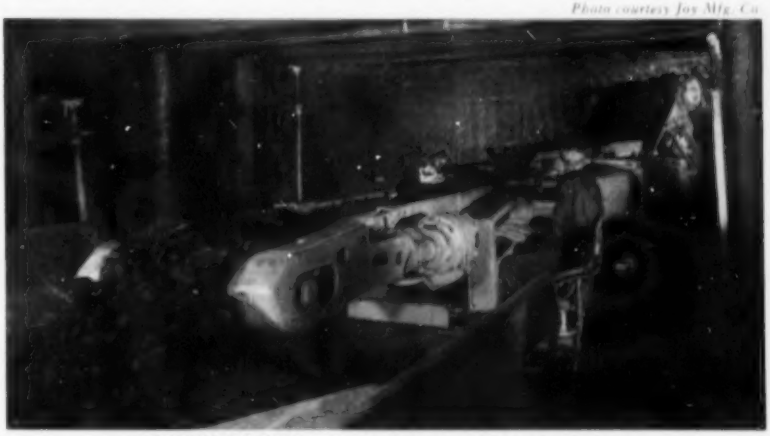
These are only two of the many success stories reported by refiners using DMD to combat mercaptide problems and complaints. And many refiners have found that since the cost of adding effective amounts of DMD is so low, it pays to use it as an "insurance" against copper contamination in a wide variety of products.

Greases containing Du Pont Estersil GT prove highly successful in many types of service

It was about two years ago that Du Pont estersil grease thickener was first introduced.

Since then, millions of pounds of grease made with this unique thickening agent have been used in a wide variety of industrial and automotive applications. And the success obtained with these greases has been truly outstanding.

Photo courtesy Joy Mfg. Co.



CONTINUOUS MINER—completely lubricated with estersil grease

One coal mining company, for example, reports that they eliminated the need for using three different mining equipment lubricants by standardizing on semi-fluid estersil-based grease in their continuous miners, loading machines and shuttle cars.

In the gear cases of the continuous miners, this company, before using an estersil grease, had a lubricant consumption of two to three *gallons* per shift. When they changed to an estersil grease, they found that the average consumption immediately dropped 75% to two to three *quarts* per shift. On loaders they actually stopped keeping records because the consumption was so small.

Longer gear life

When rebuilding machines, this same company had almost always replaced bearings and gears. But since switching to the estersil grease, they found that the gears could be used over and over again without significant wear. This was probably due — at least partially—to the fact that the estersil grease effectively sealed out moisture, dirt, coal dust and other abrasive foreign matter.

Maintenance costs down

Another user in the coal industry re-

ADVERTISEMENT—Prepared for the Petroleum Chemicals Division of E. I. du Pont de Nemours & Company (Inc.)

OVER

DU PONT

PETROLEUM CHEMICALS DIVISION
NEWS

DU PONT

CONTINUED *Estersil GT*

ports that the use of an estersil-based grease has caused his maintenance costs on a group of cutting machines to drop from .185 cents per ton to less than .09 cents per ton—a 50% saving.

Many users report that equipment runs much cooler and quieter with estersil-based greases.

In addition to heavy-duty industrial applications, estersil greases have been used in several automotive applications. In passenger cars, test engineers

THIS DEMONSTRATION dramatizes the unusual water resistance of estersil greases. They can be immersed in boiling water for long periods without breakdown.

report, these greases greatly prolong the smoother, easy-riding effect of a fresh lube job.

In heavy-duty earth-moving equipment, estersil greases often provide significant savings in downtime and maintenance costs. In some instances, crane and shovel operators reported an almost immediate cessation of leakage from hoist drum bearings on to the brake bands after switching to estersil grease.

Exceptional water resistance

Du Pont Estersil GT is an entirely *new type* of grease thickener. It is a pelletized form of finely divided amorphous silica. One of its unique features is that each minute particle is enveloped in a chemical "raincoat" which gives estersil-based greases positive, built-in water resistance and eliminates the danger of washout.

Continued middle next column

ASSISTANT TO THE SALES MANAGER—ADDITIVES

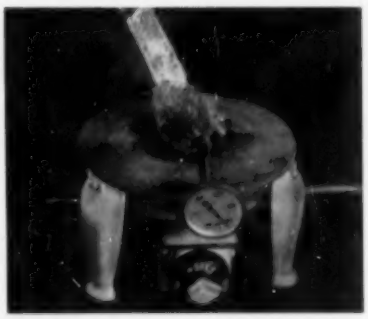
RICHARD O. BRAENDLE joined the Du Pont Company in 1944 after receiving his B.S. degree in Chemical Engineering at Massachusetts Institute of Technology.

He was first assigned to the Grasselli Chemicals Department's Experimental Laboratory in Cleveland. There he did development research on inorganic chemicals, mainly estersils. In 1950, he was transferred to the Du Pont Experimental Station in Wilmington where he worked on the application of estersils as grease thickeners.

He joined the Technical Section of the Petroleum Chemicals Division in 1952, continuing his product development work on estersil GT. During 1955 he did market research analysis for a number of petroleum additives which led to his current assignment as assistant to the sales manager for additives.

During World War II, Mr. Braendle served in the U. S. Army as a researcher and supervisor of a manufacturing operation on the Manhattan Project. He is a member of the American Chemical Society and the American Society of Lubrication Engineers.

RICHARD O. BRAENDLE



ESTERSIL GT greases stand up unusually well even under the combined action of intense heat and vigorous mechanical working.

Excellent heat and shear stability

Estersil greases are non-melting, and extremely wide temperature ranges produce little change in their consistency.

Even under prolonged high-shear, high-temperature operating conditions, greases made with Du Pont Estersil GT show outstanding resistance to mechanical breakdown.

Handling qualities

Greases thickened with estersil can be easily handled in any application—because their unusually high thermal and mechanical stability permits use of a much softer grease.

Estersil greases can be easily made, too. A milling operation is all that is required because of the completely synthetic, preformed thickening structure of estersil GT.

A Du Pont Petroleum Chemicals Division representative will be glad to give you more detailed information on estersil GT. Contact any of our sales offices listed below.

DU PONT

Better Things for Better Living
. . . *through Chemistry*

Petroleum Chemicals

E. I. DU PONT DE NEMOURS & COMPANY (INC.) *Petroleum Chemicals Division* • *Wilmington 98, Delaware*

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LOS ANGELES 17 — 612 So. Flower St.	MAdison 5-1691	SEATTLE 3 — Room 215, 4003 Aurora Ave.	MElrose 6977
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OTHER COUNTRIES: Petroleum Chemicals Division—Export Sales—Room 7496, Nemours Bldg.—Wilmington 98, Del.—OLympia 4-5121, Ext. 2962

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A-2826

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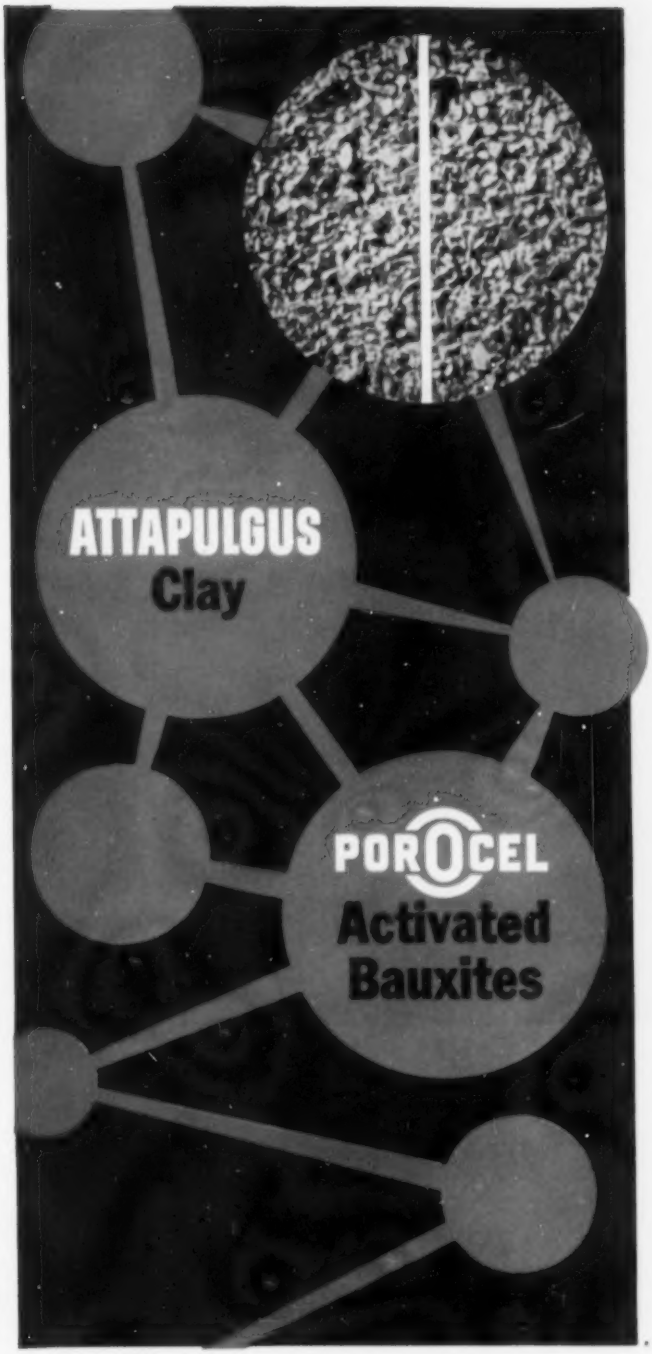

Here's the way to tackle a sorptive-mineral job

Away up in number two slot in a list of nearly 2,000 different chemicals used in petroleum refining operations is *sorptive minerals*. And the adsorbents recognized as standards in the industry are Minerals & Chemicals products—Attapulgus Clay . . . Porocel Activated Bauxites. That means there's a *headquarters* to turn to!

Want To Purify By Adsorption? There's an M&C adsorbent to fit your process scheme for removing odors, colors, taste, moisture, acids, sulfur compounds, fluorides and unsaturates from process liquids or gases.

Catalyst Carrier? M&C sorptive minerals are of highest importance in a wide variety of hydrocarbon conversion and sweetening processes.

What Do You Want To Dry? M&C offers a complete line of reliable desiccants for drying air, hydrogen, CO_2, hydrocarbon liquids and gases.

HERE'S THE NEWEST APPLICATION *of sorptive minerals in the petroleum field. Mail the coupon for your free copy of "Preparation of Petroleum Feeds for Platinum Catalysts"—and for other assistance if desired.*

ATTAPULGUS *and* **POROCEL PRODUCTS** *from*

MINERALS & CHEMICALS CORPORATION OF AMERICA
15 ESSEX TURNPIKE, MENLO PARK, N. J.

ALWAYS A BETTER WAY . . .

MINERALS & CHEMICALS CORPORATION OF AMERICA
15 Essex Turnpike, Menlo Park, N. J.

☐ Please send me "Preparation of Petroleum Feeds For Platinum Catalysts."

☐ Please provide technical help (and samples) on the following proposed applications: _____

_____

name _____ title _____

company _____

address _____

city _____ zone _____ state _____

 (To obtain more data on advertised products see page 182)

Specify

J-M THERMOBESTOS®—the heat insulation designed for outdoor process industries

For insulating outdoor process equipment, only Johns-Manville Thermobestos adds so many physical advantages to unsurpassed insulating efficiency.

To its low thermal conductivity, there's the welcome addition of strength and rigidity. Similar in chemistry to Portland cement, Thermobestos resists crushing . . . easily withstands unusual operating abuse without appreciable damage. As for weight, you can lift even the largest piece of the material with one hand. And, of course, Thermobestos is not damaged by prolonged wetting or exposure to water vapor.

This unique combination of properties means excellent temperature control (to 1200F) and minimum maintenance cost. It is ideal for oil refineries, chemical processing plants and other plants with outdoor vessels and hot piping.

Made from hydrous calcium silicate, Thermobestos is molded to size for proper fit. Its high strength makes it particularly adaptable for time-saving shop prefabrication of fittings and bends. Thermobestos is easy to apply, and is furnished in large sections which reduce the number of joints. In half-section form it comes in sizes up to 24″ pipe diameter by 3″ thickness. Also available in 6″ x 36″ and 12″ x 36″ blocks in a full range of thicknesses. For information write to Johns-Manville, Box 14, New York 16, N.Y. In Canada, Port Credit, Ont. Ask for brochure IN-169A.

Johns-Manville *first-in* **INSULATION**

MATERIALS · ENGINEERING · APPLICATION

(To obtain more data on advertised products see page 182)

Ohio

CAST ALLOY STEEL PIPENDS

EXTRA HEAVY BACK WALLS

100% MAGNAFLUX

18 X 14 REDUCING LATERAL FOR STEAM SERVICE 2005 LBS. AT 1000° F.

STANDARD BUTT WELDING FITTINGS TO ASA B-16.9

DOUBLE TEE FOR HYDROFORMING SERVICE

OHIO STEEL OFFERS

single responsibility

direct supervision

ENGINEERING
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THE OHIO STEEL FOUNDRY CO.

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ORBI

McKee expands again to give you

BETTER ENGINEERING AND CONSTRUCTION SERVICES

One of 15 specialized engineering groups in the McKee organization.

THERE are good reasons for the continuous growth of the McKee organization. Because of broad expansion of the industries we serve, our specialized, world-wide services are in greater demand than ever before in our fifty-year history. This demand, in turn, creates unusual opportunities which attract additional engineering and technical experts to the large McKee staff.

To accommodate our expanded organization McKee added the modern 25,000-square-foot building shown here. Every feature of layout, lighting, air conditioning, sound insulation and efficient equipment was designed with one purpose in mind—to give you better engineering and construction services.

Ideal working conditions contribute to the efficiency of McKee engineers. Private offices and drafting rooms have modern ceiling lighting, air conditioning, floor and ceiling sound insulation and latest engineering equipment.

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McKee
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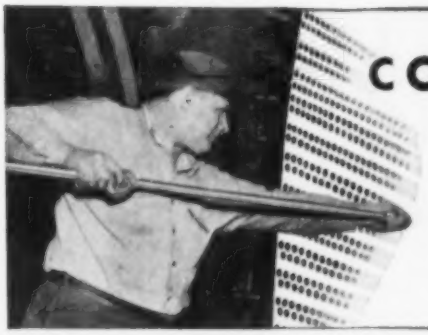
Services



CONDENSER TUBE CLINIC

Edited by **ARTHUR W. TRACY**, Metallurgical Engineer,
The American Brass Company, Waterbury, Connecticut

Stresses and their Effects can be Minimized

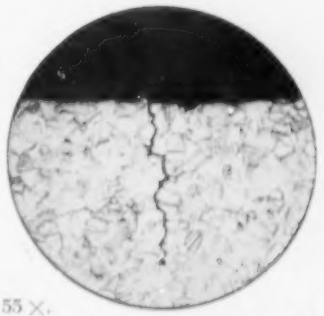
STRESS-CORROSION CRACKING—The stress-corrosion cracking of copper alloys requires the simultaneous action of moisture, air, ammonia, and stress. Stresses may be residual or applied. All Anaconda condenser tubes are processed so as to minimize residual tensile stresses which may be formed during fabrication. Applied stresses from installing tubes in heat exchangers, nonuniform thermal expansion in tube bundles, or misalignment of condensers with other equipment occasionally cause stress-corrosion cracking.

Admiralty metal and aluminum brass tubes, although known to be susceptible to stress-corrosion cracking, seldom crack in condensers. Although ammonia is often present, either by chance or design, in vapors entering condensers, the amount of air (oxygen) is usually so small that the corrosive action of the ammonia is limited. It is obvious that noncondensable gases should be vented from condensers, not only to increase thermal efficiency, but to minimize corrosion.

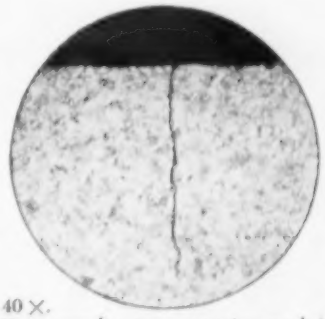
ANACONDA Arsenical Admiralty-439 and ANACONDA Ambraloy-927 condenser tubes seldom stress-corrosion crack in normal service. Where operating conditions are severe enough to cause stress-corrosion cracking of these alloys, ANACONDA Cupro Nickel, 10%-755 and ANACONDA Cupro Nickel, 30%-702 tubes are recommended.

FATIGUE CRACKING—Vibrations from moving parts of equipment or from pressure pulsations can induce stresses in condenser tubes high enough to exceed the endurance limit and cause a fatigue-crack failure. Vibration of a tube may even disturb water flow enough to cause impingement pitting at the point of greatest amplitude of vibration and the resulting pits can act as stress raisers. Pulsations can often be dampened by placing baffles or grids in the path of high-velocity vapors. Vibration of tubes can also be dampened by placing wooden slats between rows of tubes. Cupro Nickel, 30%-702 Tubes are more resistant to fatigue cracking than admiralty and aluminum brass.

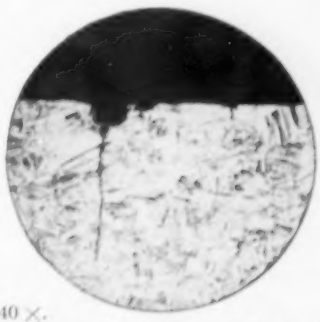
TECHNICAL ASSISTANCE—Your tube problem may need special consideration. We are always ready to advise in the selection of the right alloy to give the best service. Write for the new edition of Publication B-2. The American Brass Company, Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ont.



55 ×.
Intergranular stress-corrosion crack in 70/30 brass tube from oil refinery heat exchanger. Longitudinal section.



40 ×.
Transgranular stress-corrosion crack in admiralty metal tube from oil refinery heat exchanger. Longitudinal section.



40 ×.
Fatigue crack starting at pit in aluminum brass tube from power plant condenser. Longitudinal section.

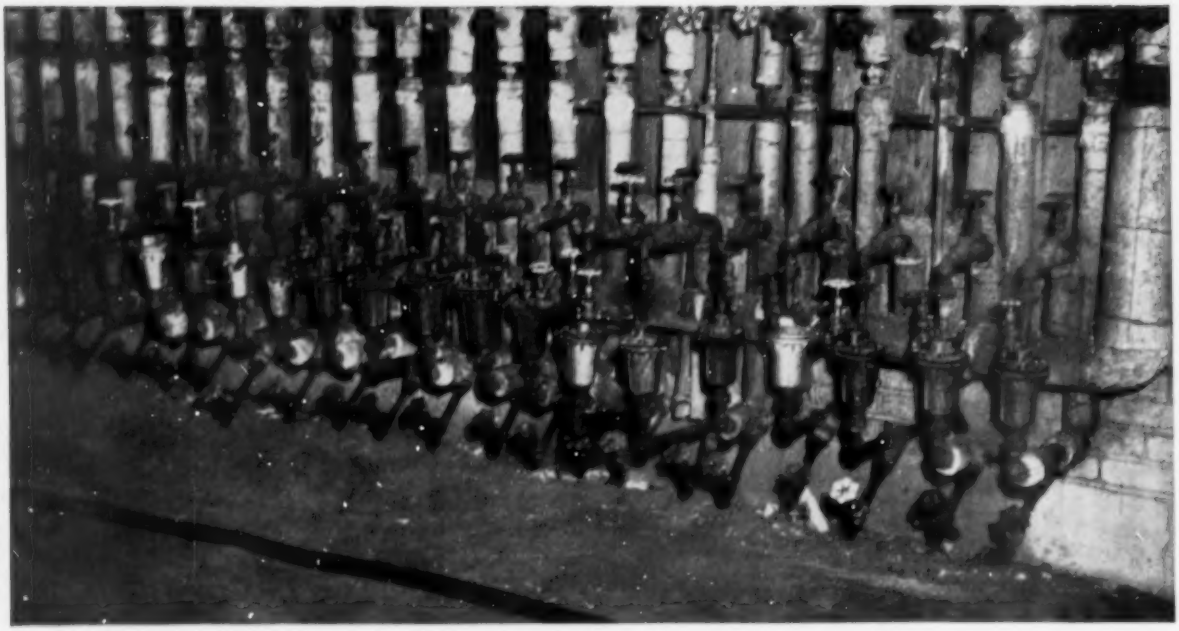
ANACONDA® **Tubes and Plates for Condensers and Heat Exchangers**

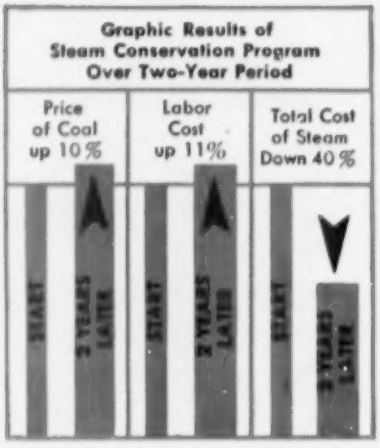
Nominal Compositions of Some Anaconda Condenser Tube Alloys

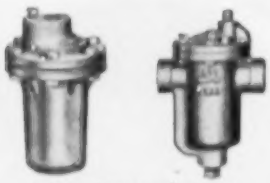
	Arsenical Admiralty -439	Ambraloy -927 (Aluminum Brass)	Cupro Nickel, 10%-755	Cupro Nickel, 30%-702
Copper, %	71	77	88.35	68.90
Nickel, %	..	..	10	30
Zinc, %	27.96	20.96	..	..
Aluminum, %	..	2	..	..
Tin, %	1	..	..	..
Arsenic, %	0.04	0.04	..	..
Manganese, %	..	..	0.40	0.60
Iron, %	..	..	1.25	0.50

 (To obtain more data on advertised products see page 182)

How a Major Chemical Company Cut Steam Costs $100,000 Annually







Trap sizes and styles
for every condensate drainage job.

Armstrong Traps were a "Major Factor" in Steam Conservation Says Chief Engineer

Steam waste has a way of creeping up on you. Especially in older plants. The losses can make a staggering total.

Plants looking for a way to fight rising costs can well take a page from the 8-point steam conservation program that netted a major chemical plant $100,000 annual saving:

1. **Waste steam utilized** — all flash steam recovered for building heating.
2. **New steam traps installed** — Armstrong traps replaced old traps throughout the plant, indoors and out.
3. **Steam leaks repaired.**
4. **Insulation repaired.**
5. **All condensate recovered.**
6. **Steam piping simplified.**
7. **Steam turned off when not needed.**
8. **Preventive maintenance improved** to insure a continuous checkup on sources of waste.

In commenting on the program, the Chief Engineer of the plant stated, "*4000 new Armstrong steam traps were one of the major factors in conserving steam. The traps, plus improved installation practice, have reduced annual trap maintenance parts and labor by $25,000 as compared to traps previously used.*"

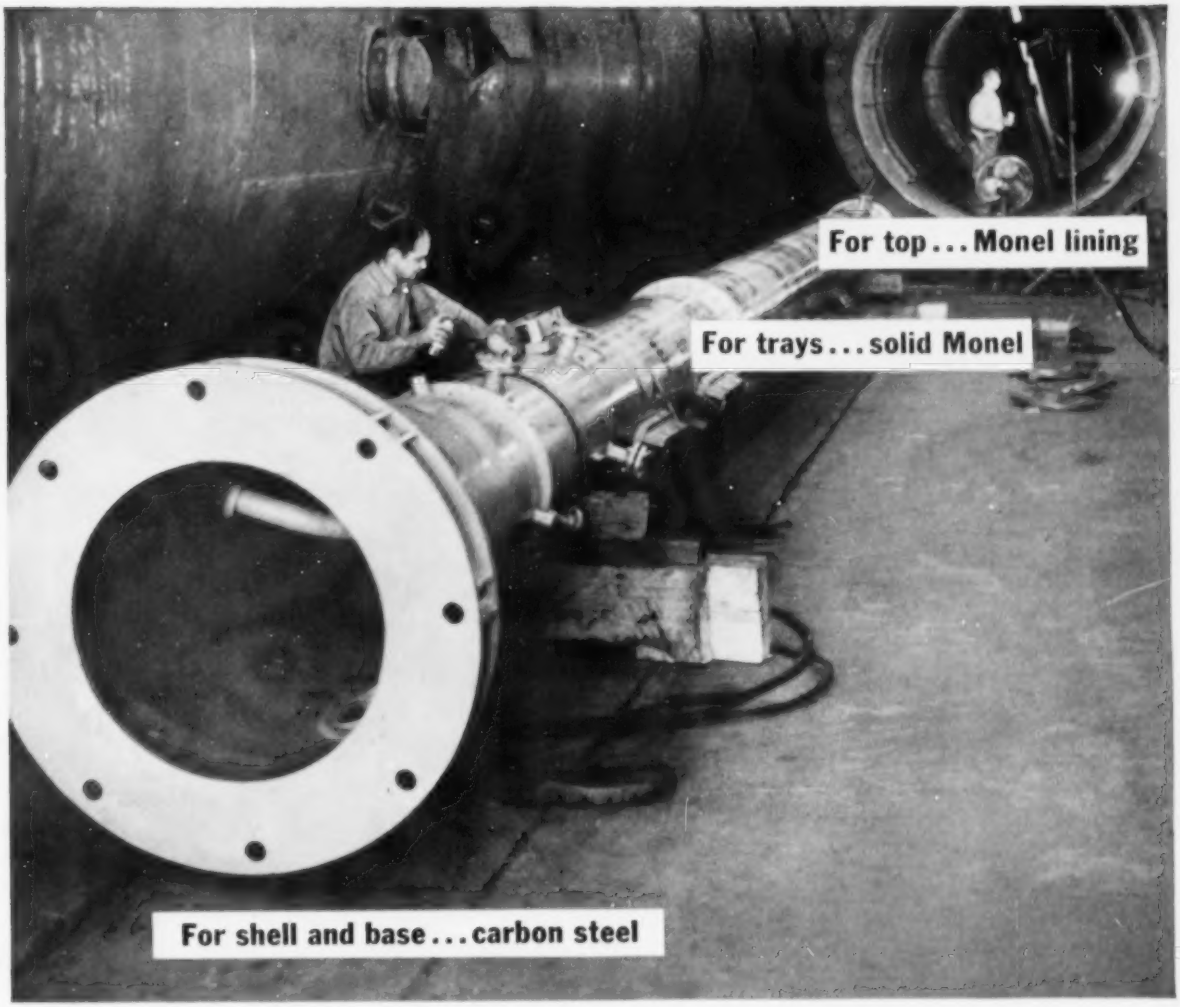
Want all the facts? Tips on cost-saving standardized trap hookups? Facts about Armstrong traps? Ask for:

1. The No. 1, 1956 issue of the Armstrong Trap Magazine containing complete details, drawings and photos.
2. The 44-page Armstrong Steam Trap Book, a fact-full guide to better trapping.

Call your local Armstrong Representative or write:

ARMSTRONG MACHINE WORKS
826 Maple St., Three Rivers, Michigan

ARMSTRONG STEAM TRAPS



Monel combined with steel for economy in new fractionator

The complication in economical tower engineering is corrosion.

How much to accept? What corrosives are present? Where? How do temperature, pressure and stream velocity affect their action? Product clarity requirements? Materials capabilities? Fabricating precautions?

Often, definitive answers to questions like these prove unattainable without great expense. Fortunately, experience has shown a practical way to cut through the difficulty.

Take the tower shown. The company's engineers had experience with Monel* nickel-copper alloy . . . were familiar with its outstanding ability to resist tower-top corrosives . . . aqueous hydrochloric and sulfuric acids, and various salts.

With this in mind, they called on engineers from the fabricator, Fritz W. Glitsch & Son, Inc., for help in pinning down probable corrosion trouble spots. These men, in turn, worked with Inco's Corrosion Engineering Section.

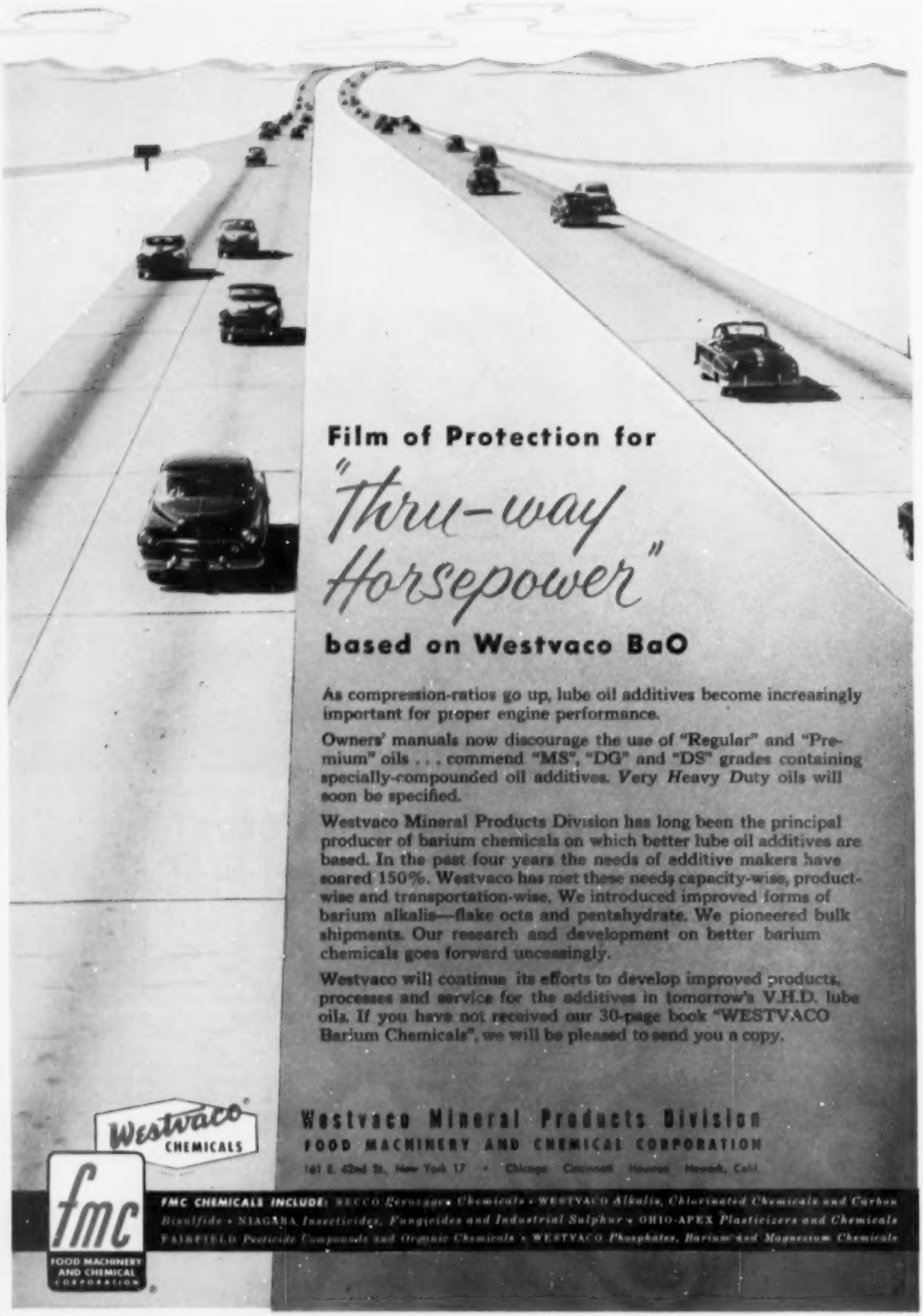
Final "specs" put Monel alloy at each trouble spot, carbon steel elsewhere. Above the probable dew line (the top 15 feet, 6 inches), 3/32-inch Monel alloy lining was used. The eight trays (where agitation intensifies corrosion) were a special Glitsch design done in this same solid nickel-copper alloy.

It's good business to make tower engineering a *team* affair . . bringing in the experience of your own engineers and consultants, the fabricator's and Inco's. You are better assured of economical construction and reliable tower operation.

*Registered Trademark

The International Nickel Company, Inc.
67 Wall Street New York 5, N. Y.

INCO **Nickel Alloys Perform Better, Longer**


Film of Protection for
"thru-way Horsepower"
based on Westvaco BaO
As compression-ratios go up, lube oil additives become increasingly important for proper engine performance.
Owners' manuals now discourage the use of "Regular" and "Premium" oils . . . commend "MS", "DG" and "DS" grades containing specially-compounded oil additives. Very Heavy Duty oils will soon be specified.
Westvaco Mineral Products Division has long been the principal producer of barium chemicals on which better lube oil additives are based. In the past four years the needs of additive makers have soared 150%. Westvaco has met these needs capacity-wise, product-wise and transportation-wise. We introduced improved forms of barium alkalis—flake octa and pentahydrate. We pioneered bulk shipments. Our research and development on better barium chemicals goes forward unceasingly.
Westvaco will continue its efforts to develop improved products, processes and service for the additives in tomorrow's V.H.D. lube oils. If you have not received our 30-page book "WESTVACO Barium Chemicals", we will be pleased to send you a copy.
Westvaco Mineral Products Division
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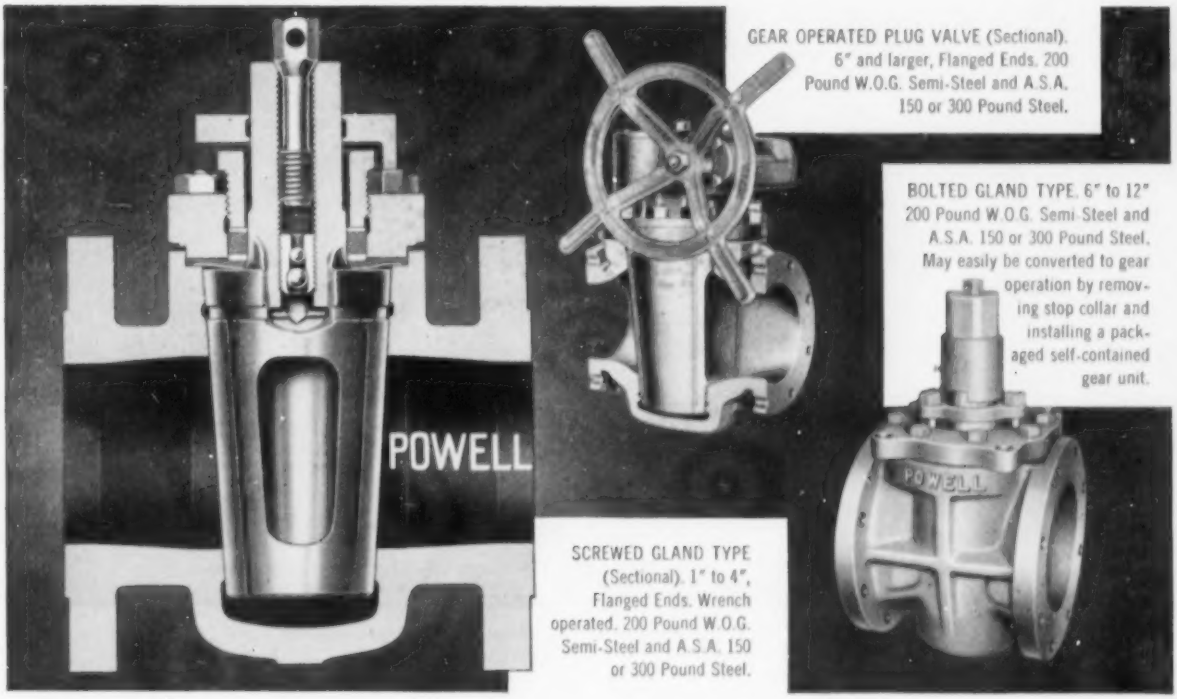
FMC CHEMICALS INCLUDE: BECCO Peroxygen Chemicals • WESTVACO Alkalis, Chlorinated Chemicals and Carbon Bisulfide • NIAGARA Insecticides, Fungicides and Industrial Sulphur • OHIO-APEX Plasticizers and Chemicals FAIRFIELD Pesticide Compounds and Organic Chemicals • WESTVACO Phosphates, Barium and Magnesium Chemicals

POWELL

Lubricated Plug

VALVES



GEAR OPERATED PLUG VALVE (Sectional). 6" and larger, Flanged Ends. 200 Pound W.O.G. Semi-Steel and A.S.A. 150 or 300 Pound Steel.

BOLTED GLAND TYPE. 6" to 12" 200 Pound W.O.G. Semi-Steel and A.S.A. 150 or 300 Pound Steel. May easily be converted to gear operation by removing stop collar and installing a packaged self-contained gear unit.

SCREWED GLAND TYPE (Sectional). 1" to 4", Flanged Ends. Wrench operated. 200 Pound W.O.G. Semi-Steel and A.S.A. 150 or 300 Pound Steel.

Powell Lubricated Plug Valves maintain our 110-year tradition of quality and precision. Only the finest available materials are used. And painstaking quality control is rigidly enforced through each and every step of manufacture.

Features include quick and positive operation—just a quarter-turn to open or close. Lubricant grooves surrounding each port provide a positive seal when the valve is closed. In an open position, seating surfaces are not exposed.

Valve users who want one source of supply for lubricated plug as well as all types of bronze, iron, steel and corrosion-resistant valves will want full details on Powell Lubricated Plug Valves.

Available in Steel and Semi-Steel through distributors in principal cities. If none is located near you—or if you need help on valve problems—write direct to

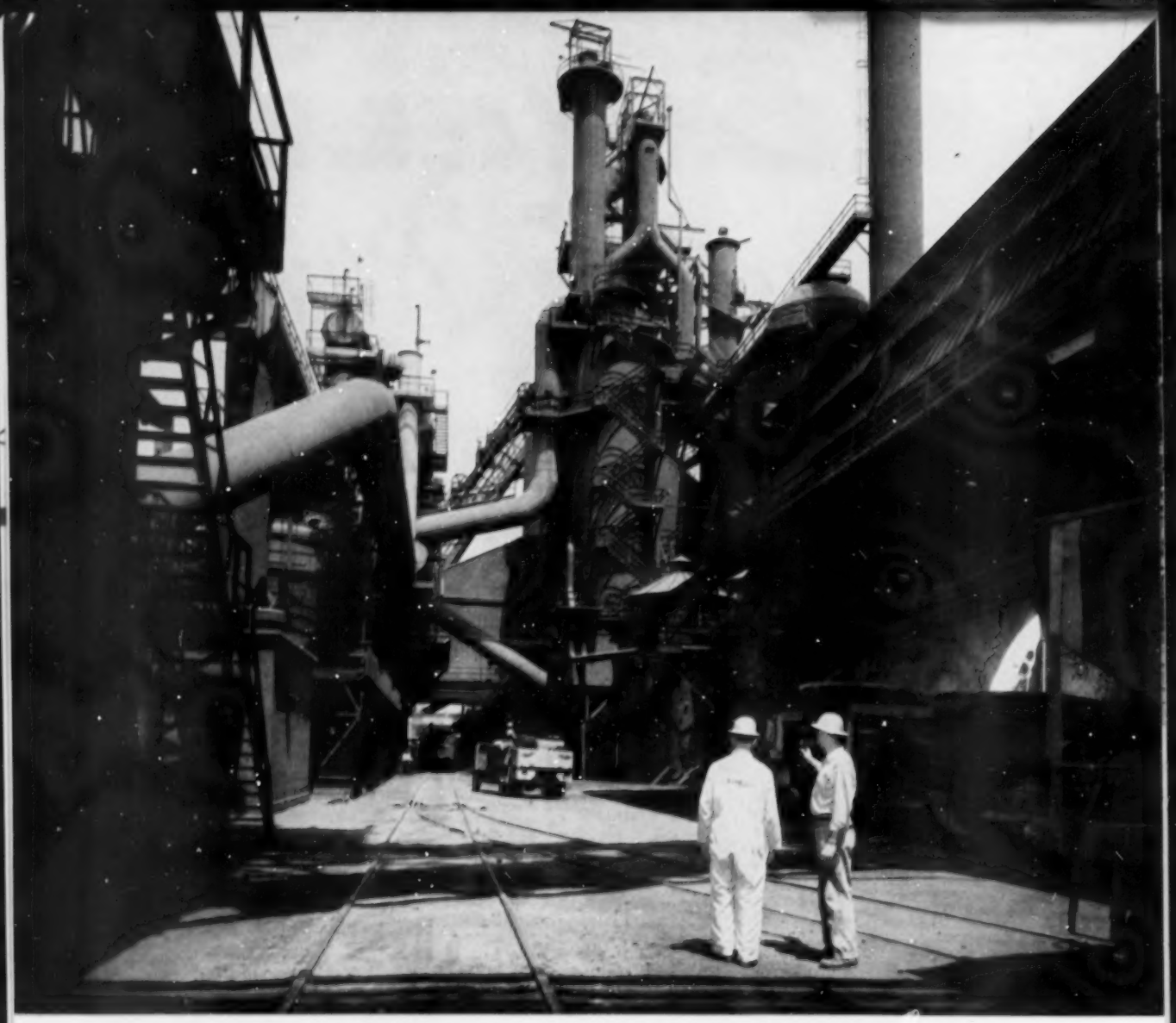
PERFORMANCE PV VERIFIED

BRONZE, IRON, STEEL AND CORROSION-RESISTANT VALVES

The Wm. Powell Company, Cincinnati 22, Ohio . . . 110th YEAR

The source of supply for all valve needs!

 (To obtain more data on advertised products see page 182)



CHEMICAL CLEANING AT THE FORD MOTOR COMPANY, RIVER ROUGE, MICHIGAN

Dowell chemical cleaning gets results for Ford

When you have men and costly equipment in your care you don't take chances. That applies to chemical cleaning, too.

You—like Ford—want the company and the men who do your chemical cleaning to fulfill certain requirements. They must be as safety conscious as you are. This has to be your number one requirement.

Next, you want these men to have extensive experience so that you get the best possible job. And you want them to be backed by research facilities, because you know the best possible job can be done only when the latest developments are employed.

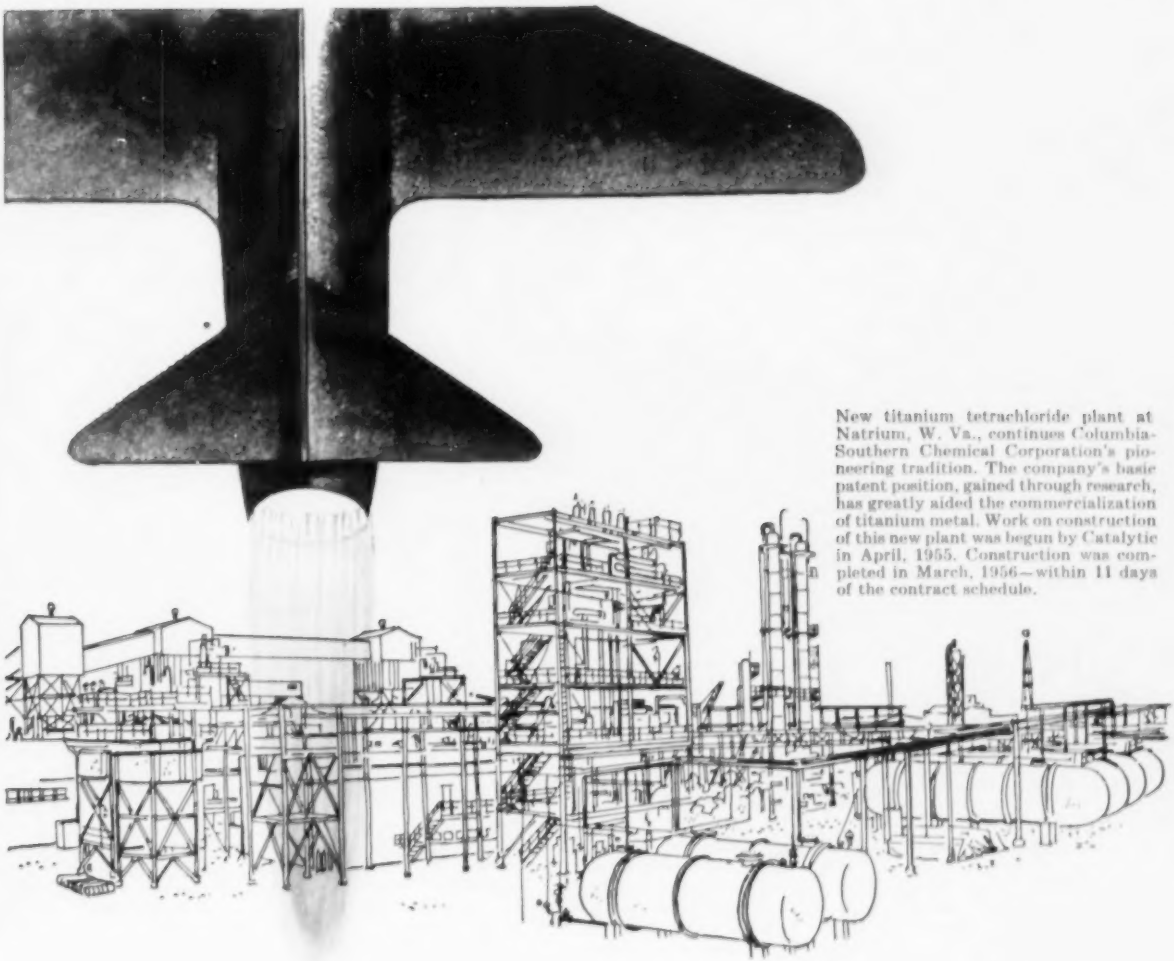
These requirements are basic with Dowell, as thousands of companies throughout the country can testify. You get them and many more when you have Dowell do your chemical cleaning.

Don't take chances. Have your chemical cleaning done by experts. When you want maximum safety and efficiency backed by research in your chemical cleaning—call Dowell. Or write Dowell Incorporated, Tulsa 1, Oklahoma, Dept. K-32.

chemical cleaning service for industry

DOWELL

A SERVICE SUBSIDIARY OF THE DOW CHEMICAL COMPANY



New titanium tetrachloride plant at Natrium, W. Va., continues Columbia-Southern Chemical Corporation's pioneering tradition. The company's basic patent position, gained through research, has greatly aided the commercialization of titanium metal. Work on construction of this new plant was begun by Catalytic in April, 1955. Construction was completed in March, 1956—within 11 days of the contract schedule.

$TiCl_4$
(Titanium tetrachloride)

A new multi-million dollar plant at Natrium, W. Va., is the answer of *Columbia-Southern Chemical Corporation* to the task of producing $TiCl_4$—titanium tetrachloride—which in turn is used in production of titanium.

Titanium is metallurgy's answer to the need for metal resistant to high temperatures—as in supersonic aircraft.

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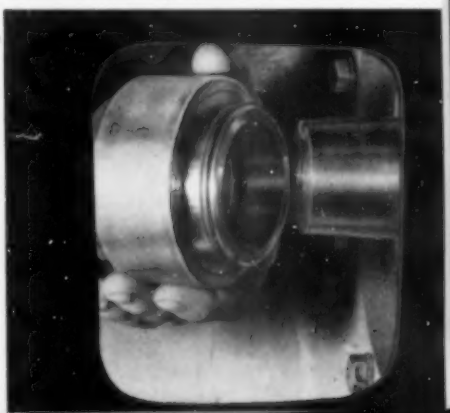
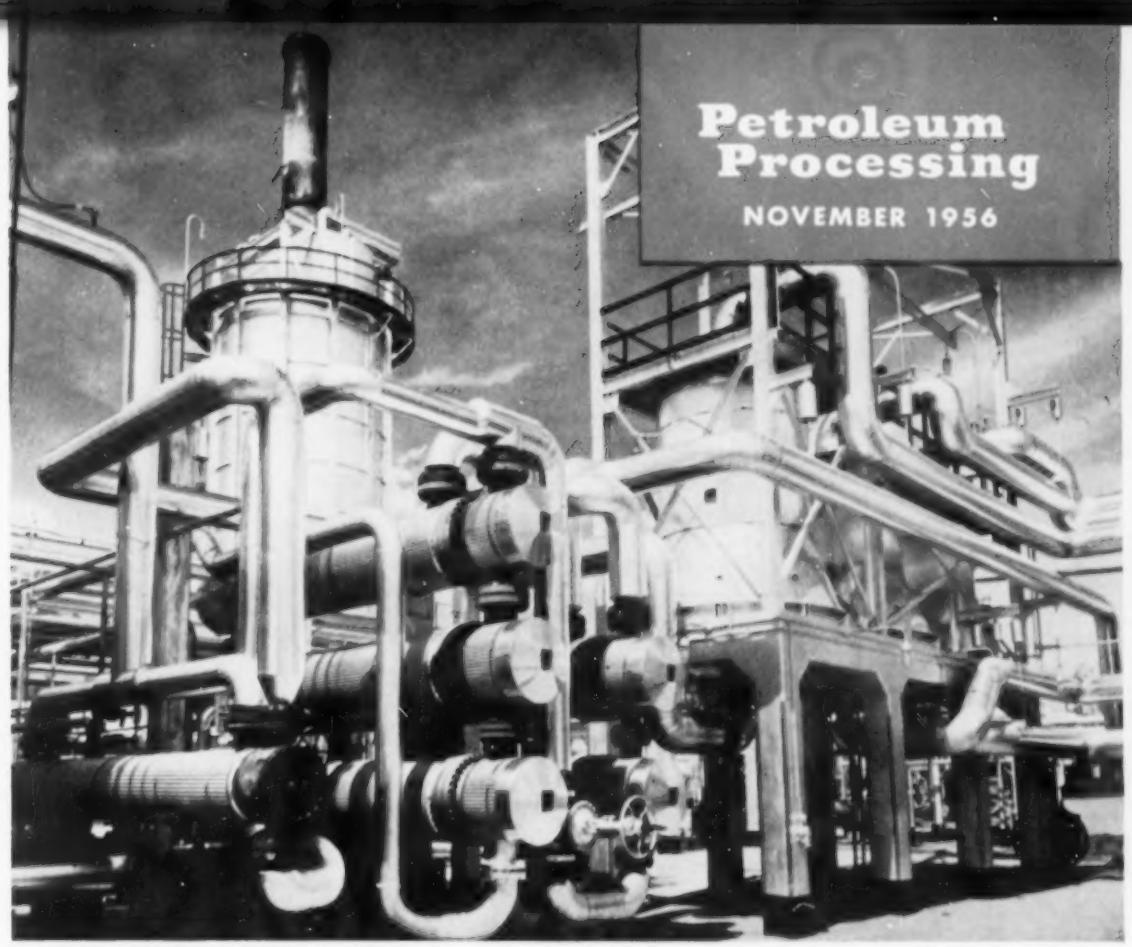




REACTORS for Cosdens new 3870 b/sd Rexformer are three cases at right

Cosden's New Rexformer

First "brand new" unit makes over 104 octane in test run

THE WORLD'S first commercial Rexforming unit to be built new from the ground up is now on stream, and has already made gasoline testing over 104 octane, leaded. The 3870 b/sd unit is at Cosden Petroleum Corp.'s 30,000 b/d Big Spring, Texas, refinery. It went on stream July 27 and was shown to a group of visiting refiners at an open house Sept. 19.

(Another Rexformer, 5500 b/sd, has been in operation since April at Aurora Gasoline Co.'s Detroit, Mich., refinery, but was built by remodeling an existing Platformer. A third Rexformer, 6000 b/d, is under construction at the Ponca City, Okla., refinery of Cities Service Oil Co.)

Rexforming is a process developed by Universal Oil Products Co. that combines catalytic reforming (over a fixed bed platinum catalyst) with a solvent extraction unit (employing aqueous glycol). The solvent selectively removes aromatics and certain light, high-octane paraffin hydrocarbons as gasoline product. The heavier, low-octane paraffins, which are relatively insoluble in the solvent, are recycled for further reforming.

One advantage claimed for Rexforming is that only moderately severe reforming conditions are employed, because it is not necessary to compensate for the equilibrium-limiting aromatics formation that develops in once-through Platforming to high octane levels. The unreacted paraffins in the reactor effluent are continuously recycled in Rexforming, whereas conversion must be much more complete in the essentially single-pass Platforming operation.

The Cosden test run that yielded product of over 104 octane (F-1, plus 3 cc of tetraethyl lead), was made from the processing of a fresh feed consisting predominantly of West Texas straight-run naphtha and a depentanized natural gasoline, along with small amounts of other refinery streams. The straight-run naphtha portion derived from sour crude had been subjected to desulfurization in a new 2100 b/d Unifiner. Yields of 79 liquid vol% are expected when operating at this octane level.

The unit has been designed to produce a minimum of 98 octane product (F-1, clear), or about 102.5 octane when leaded. Table 1 gives data on

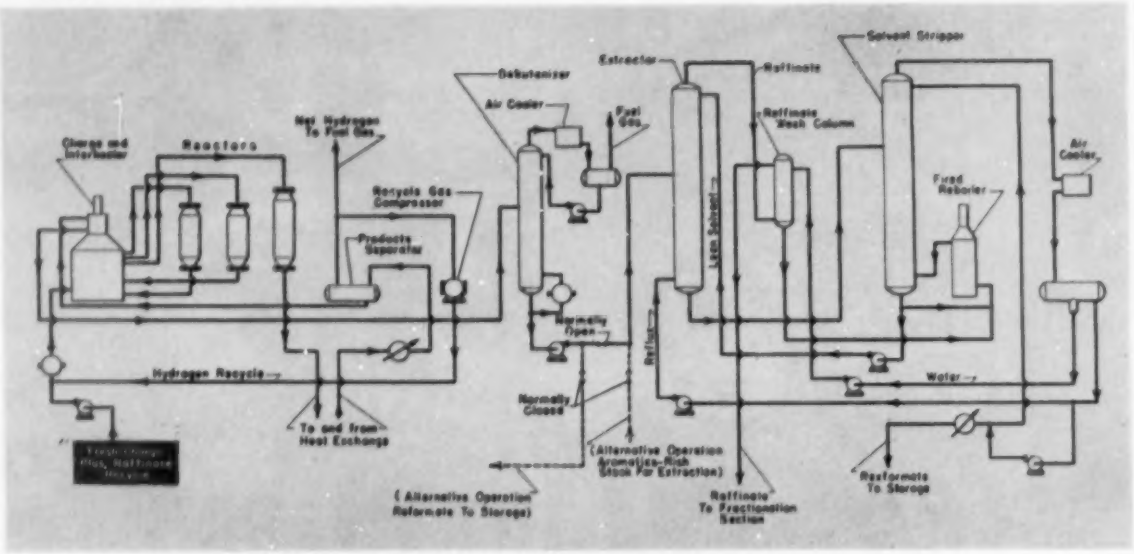


Fig. 1—REXFORMING flow diagram, with reactor section at left, extraction and solvent recovery at right

feed stock and product for an earlier test run that yielded product of 103.4 octane leaded.

Cosden's new Rexformer supplements an existing 4500 b/d Platformer-Udex installation in operation since 1952. This unit will now be used exclusively for manufacture and recovery of benzene, toluene and xylene. It is presently producing 1300 b/d of nitration grade aromatics. Formerly, the Platformer was operated under a blocked-out scheme to produce alternately motor fuel blending stocks and aromatics.

Flow Through Rexformer

Fig. 1 is a schematic flow diagram of the Rexforming unit. The catalytic reforming section of the Rexformer consists of a heater containing three separate coils for charge and interheat service, plus a debutanizer preheat coil in the convection section; three fixed bed reactors containing UOP Platforming catalyst; a product separator, and a debutanizer. The overhead product condenser on the debutanizer, incidentally, uses air rather than water; industrial cooling water is a scarce commodity in arid West Texas.

The debutanized reactor effluent is charged to a liquid-liquid extraction column, where it meets a descending stream of the glycol-water solvent in countercurrent flow. The rich solvent is refluxed with a small stream of reformate before leaving the tower to knock back any low octane paraffinic hydrocarbons that might have penetrated to this point in the column.

Table 1—Feed Stock and Product Data on Cosden's Rexformer

	Feed	Product
Gravity, °API	56.4	43.2
ASTM Distillation, °F.:		
IBP	168	149
10%	184	184
30%	214	—
50%	244	258
70%	286	—
90%	328	338
EP	390	394
Sulfur, Wt—%	0.019	—
Hydrocarbon Types:		
Paraffins	54.2	—
Olefins	0	—
Naphthenes	36.1	—
Aromatics	9.7	64.2
F-1 Octane, clear	52.5	98.2
+ 3cc TEL/gal	75.0	103.4*

*Wiese Octane Scale Extension

Is Isomerization Cosden's Next Move?

The fractionation section of Cosden's new Rexformer indicates that the next step in this company's program for higher quality gasolines may be catalytic isomerization of normal pentane and hexane. An n-pentane stream is now being recovered in the fractionation scheme. Space has been left in the plant layout for another column, which could be used to separate normal and iso-hexane, the former as isomerization feed stock.

The overhead product of the extractor, the raffinate, is predominately paraffinic. Extraction conditions are selected so that, in general, the high-boiling, low-octane hydrocarbons are concentrated in this stream. These materials, while low in antiknock quality, are the very paraffins that are particularly susceptible to conversion to aromatics and are, therefore, continuously recycled to the catalytic reactor section. Alternatively, their highly paraffinic nature makes them desirable also as high quality compoents of jet fuel.

The raffinate may contain a small amount of glycol solvent. Therefore a water wash is provided for this stream, the resultant diluting of the glycol being sufficient to spring it from the raffinate.

The rich solvent stream from the bottom of the extraction column is stripped of hydrocarbons in the solvent stripper. The column is operated to produce the Rexformate product overhead and a glycol bottom product for return to the extractor. Composition of the bottom product is controlled to give the desired solvent action in the extraction column. "Excess" water in the charge to the stripper is carried overhead with the hydrocarbons, is separated in a receiver having a water leg, and is continually recycled as washing agent in the raffinate wash column. The wash water carrying the recovered glycol enters the stripper via the inlet stream to the reboiler. Air cooling is used in the stripper overhead condenser. Subcooling of the hydrocarbon product to storage is obtained in a shell-and-tube condenser against water.

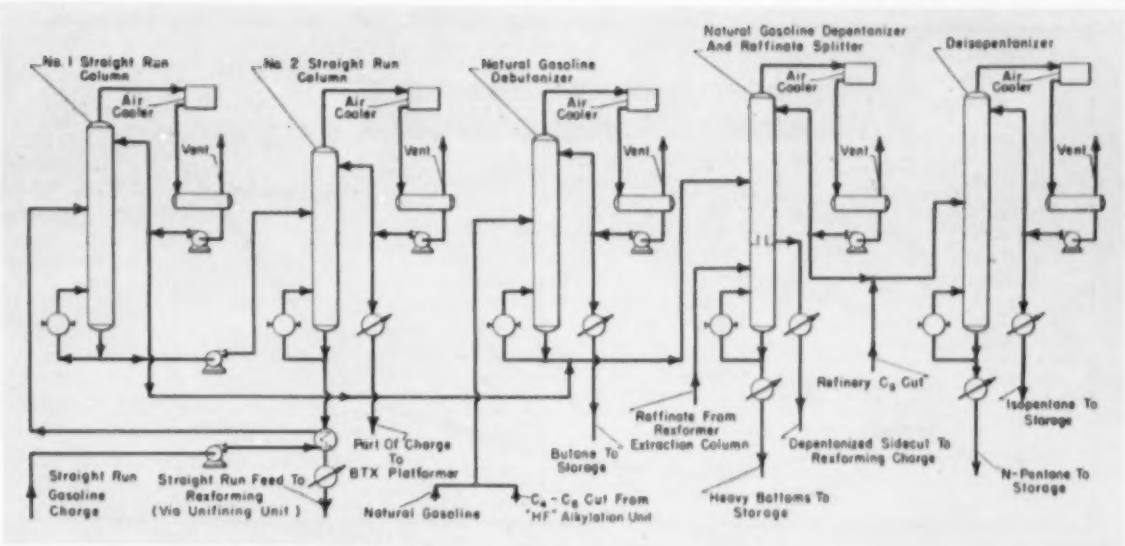

No. 1 Straight Run Column
No. 2 Straight Run Column
Natural Gasoline Debutanizer
Natural Gasoline Depentanizer And Raffinate Splitter
Deisopentanizer
Air Cooler
Vent
Straight Run Gasoline Charge
Straight Run Feed To Rexforming (Via Unifining Unit)
Part Of Charge To BTX Platformer
Natural Gasoline
Butane To Storage
C4 - C6 Cut From "HF" Alkylation Unit
Raffinate From Rexformer Extraction Column
Heavy Bottoms To Storage
Depentanized Sidecut To Rexforming Charge
Refinery C5 Cut
Isopentane To Storage
N-Pentane To Storage

Fig. 2—FRACTIONATION section, which handles feed preparation for Rexformer

Fractionation System

The new fractionation system installed in conjunction with the Rexformer supplements existing fractionation equipment in the refinery. One of its principal duties is the production of suitable feed for the Rexformer from a straight-run naphtha and a 14 lb natural gasoline. It also depentanizes the raffinate from the solvent extraction section of the Rexformer.

Additional functions of the fractionation system are the production of butane, iso- and n-pentane products, and the preparation of an increment of the charge stock for the "BTX Plant." This latter material may be predominantly C_6 through C_8 hydrocarbons, C_7-C_8 hydrocarbons, or only C_8 hydrocarbons, depending on conditions chosen for the system.

Unusual features of this unit that particularly distinguish it from the usual refinery fractionation system, are the use of air in condensing all overhead product streams, and the use of a hot oil circulating system to provide reboiler heat to all five columns. As mentioned previously, air cooling is preferable in the arid climate when process conditions permit. Because of the refinery's heat balance and boiler capacity, it was deemed desirable to substitute hot oil for the more common steam to provide reboiler heat.

The unit, Fig. 2, charges such diverse streams as debutanized straight-run gasoline, 14 lb natural gasoline, stabilizer overhead from the HF Alkylation unit, a C_5 stream from other light ends recovery facilities, and paraffinic raffinate from Rexforming. From these it produces butane, normal and isopentane, part of the straight-run fresh feed to Rexforming along with depentanized raffinate recycle, and a small quantity of heavy bottoms that may be used in a variety of ways.

Straight-run gasoline from No. 2 crude distillation unit is charged to the first column which, in "normal" flow, acts as a depentanizer. (It can be set to dehexanize.) The bottom product is feed to the No. 2 SR column, which is operated to provide the increment of desired C_6 to C_8 feed for the "BTX Plant." The bottom product from this column, which contains sulfur and other contaminants undesirable in further processing, then is fed to the Unifining unit for purification, after which it becomes part of the feed to Rexforming. The C_5 overhead from the No. 1 column is fed to the natural gasoline depentanizer.

The natural gasoline debutanizer derives the major portion of its charge from 14 lb natural gasoline purchased as an outside raw material. The natural gasoline depentanizer is a double column. It's lower section functions as a raffinate splitter in order to depentanize this recycle stream to the Rexformer. Depentanized natural gasoline is taken as a side-cut directly to Rexforming charge, carrying with it the raffinate recycle. The heavy ends from these charge stocks are taken as a bottom product to storage.

The new facilities, including the 3870 b/sd Rexformer and fractionation system, and the 2100 b/sd Unifiner, were all designed for Cosden by Universal Oil Products Co.

Construction of the Rexformer-fractionation section was handled by UOP's subsidiary, Procon, Inc., and was completed 190 days after the ground breaking Jan. 18, 1956. The Unifiner was built by Cosden's staff.

Want More Info?

Want more information on the Rexformer process, or Cosden's other installations? PETROLEUM PROCESSING has published the following articles on these subjects in recent years:

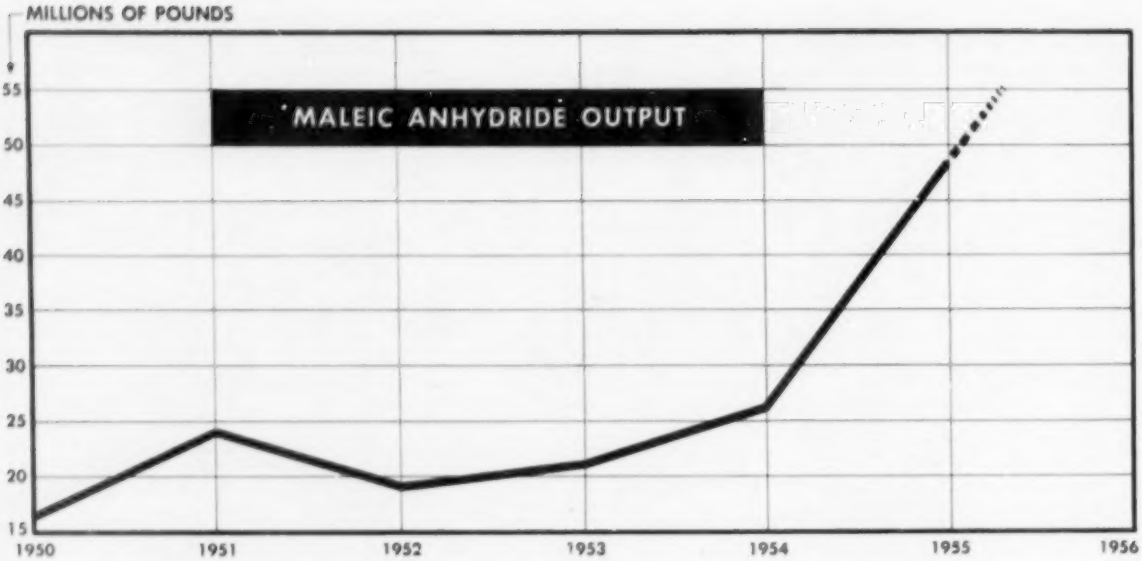
"Try Rexforming for 100 Plus," by H. W. Grote, V. Haensel, and M. J. Sterba, April, 1955, pp. 356-60.

"It's Time to Take a New Look at Catalytic Reforming," by the Editors of PETROLEUM PROCESSING, August, 1955, p. 1180 (Rexforming process description).

"Three Unusual Features in New HF Alkylation Unit at Cosden," by D. P. Thorton, Jr., October, 1954, pp. 1570-73.

"First Complete Udex 'B-T-X' Plant Makes Nitration-Grade Products," by D. P. Thorton, Jr., March, 1953, pp. 384-387.

"Remodeled Plant Is Showplace," by D. P. Thorton, Jr., January, 1950, pp. 45-48.



METEORIC PRODUCTION JUMP for maleic anhydride in 1955 followed several years of quiet.

"Hot" Petrochemical Newcomer is . . .

Burgeoning Maleic Anhydride

By PETER W. SHERWOOD
Chemical Engineer
White Plains, N. Y.

MALEIC anhydride manufacturers will remember 1955 as the year when their product "arrived." Within this single year, U. S. production capacity for this compound increased about 75%, reaching a total of 47-50 million pounds per year, up from 27 million pounds in 1954.

This has been the first significant overall expansion program in maleic anhydride facilities since 1950. Between 1950 and 1954, output had varied but little from its median line of 20 million pounds per year. Thus, 1950 production has been reported at 16.0 million pounds, 1951 output at 23.7 million pounds (the boost being largely caused by the Korean situation), 1952 production at 17.8 million pounds. The best estimate for 1953 places maleic anhydride manufacture at 20-22 million pounds.

The recent upsurge in maleic anhydride capacity is impelled by several market developments. Most important is the significant expansion in the output of maleic-based alkyd resins for surfaced coating purposes. In this field, phthalic anhydride continues to be the reigning dibasic acid, but manufacturers have drawn on more expensive maleic, partly because the product exhibits certain special desirable properties (notably high impact resistance), and partly because phthalic anhydride —like naphthalene, its primary raw material—continues to be in short supply.

Beyond that, the makers of surface coatings find uses for maleic anhydride in the production of drying oils. This market received a boost when the Chinese tung oil supply was cut back, and they had to resort to less readily processed substitutes.

Of somewhat lesser importance is the use of maleic anhydride in the production of plasticizers (notably for lacquer resins), and of various binders and dispersion agents for the paint and flooring industries.

A bright—perhaps even overoptimistic—picture has been painted for the future of structural polyester resins. Growth in this field means much to the market outlook for maleic anhydride, which constitutes up to 20-25% of different formulations.

The high chemical reactivity of maleic anhydride lends its use to numerous syntheses. It is, for example, the classic reagent in Diels-Alder syntheses. For a thorough discussion of maleic's many chemical derivatives, the reader is referred to a recent book by Flett[1].

Industrially, chemical conversions take maleic anhydride into the production of soil stabilizers, various pesticides, fungicides, plant growth regulants (maleic hydrazide), ahhesives, paper sizing materials, etc.

To give a picture of the market pattern for maleic anhydride, *Chemical Week*[2] has provided the estimate of 1955 distribution shown in Table 1.

Table 1—Maleic Anhydride Market Pattern—1955[2]

	Millions of lb
Alkyd coating resins	14-15
Polyesters (casting, low-pressure laminates)	7-8
Drying oils	6-8
Agricultural chemicals (pesticides, plant growth regulants, soil conditioners, etc.)	5-6
Plasticizers	3-4
Paper sizing, rosin-maleic adducts	2-4
Other (pharmaceuticals, wetting agents, adhesives, etc.)	4

Not shown in Table 1 are the small amounts of maleic acid, and the several million pounds of fumaric acid which are obtained from crude maleic anhydride in process.

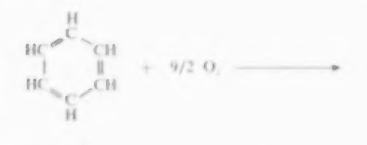
Commercial production of maleic anhydride has been by oxidation of crotonaldehyde (in wartime Germany). Furthermore, butene is a raw material of potential interest, and several, as yet non-commercialized, patents cover its partial oxidation to maleic anhydride. Today, however, there are only two actual sources for the industrial production of maleic anhydride: by-product maleic acid obtained in phthalic anhydride syntheses, and direct partial oxidation of benzene.

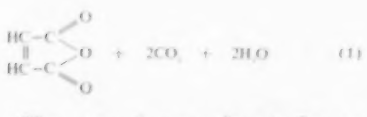
By-product maleic anhydride accounts for only some 10% of the total output of this compound. These maleic values are formed to the extent of about 2% of theory in the course of phthalic anhydride production by the air oxidation of napthalene or o-xylene. Most of the maleic anhydride obtained in this manner passes in gaseous form through the phthalic cooling and collecting chambers (hay boxes). The tail gases are water-scrubbed and here maleic anhydride is hydrolized and remains dissolved as maleic acid.

The scrubber liquors constitute a real nuisance problem and recovery of maleic anhydride from this source is practiced more to cope with the nuisance problem than because of its economic attractiveness. By-product maleic is a value which only helps pay for the cost of waste scrubber liquor disposal.

Several recovery processes are at hand. They follow the lines which are practiced to upgrade maleic acid obtained in plants designed especially for maleic anhydride manufacture, and they will be discussed below within this framework.

Partial oxidation of benzene by means of air gives the lion's share (about 90%) of maleic anhydride production:





The process bears analogy to the economically more important production of phthalic anhydride (1955 output estimated at 350 million pounds. However, the raw materials position of the maleic anhydride producer is more secure than the precarious situation which has prevailed for some years now in the phthalic industry. The reason is that, unlike naphthalene, benzene can today be made available in nearly unlimited volume from petroleum sources.

This is a development of the last eight years, which has freed the consumer of benzene from his former full dependence on coal coking operations, traditionally the source of aromatic hydrocarbons.

Expansion in the coking industries is, of course, tied to the steel industry and the manufactured gas industry. Especially the latter has seen no significant expansion during the postwar era, since it has been eclipsed by the rapid growth of long-distance transmission systems for natural gas in the United States and Canada.

For the producer of coke, benzene is but one by-product. It is by no means sufficiently important to permit adjustment in his process volume. The pace is set by requirements for coke, which represents some 75% of the value of all products obtained in the course of coal distillation. And here it must be borne in mind that the volume of coke employed even per ton of iron or steel produced is falling off. This is partly due to improved fuel efficiency in modern iron making processes and partly to increased use of high-grade iron ore (taconite) concentrates.

These factors, coupled with the conservative rate of expansion in the steel industry as a whole, and the regression of the manufactured gas industry, have been responsible for the fact that coking capacity in the U. S. has increased a mere 5% since 1948.

By contrast, benzene production since 1949 has risen from 156.6 to approx. 300 million gallons in 1955, an average increase of 11.6% per year. To be sure, maleic anhydride is only the sixth largest consumer of benzene, being outdistanced by styrene (52% of benzene output), phenol, dodeyl benzene, DDT, and aniline. Yet, the security of maleic's raw materials position rests on the overall position of benzene supply.

Only the petroleum industry has been in a position to fill the widening gap between benzene consumption and its availability from the conventional coal sources.

Petroleum-derived benzene (obtained chiefly from naphtha reformate and refined by Udex extraction and fractionation) makes up a rapidly growing percentage of domestic production as shown in Table 2.

Table 2—U.S. Production of Benzene, 1948-55 (millions of gallons)

Year	Petroleum	Coke Oven	Tar Distillates	Total
1949	.....	143.7	12.9	156.6
1950	10.1	154.5	12.4	177.0
1951	28.9	172.8	11.2	212.9
1952	31.8	155.1	9.3	196.2
1953	59.7	177.6	19.4	256.7
1954	83.7	139.4	14.4	237.5
1955	103.3	174.1	22.1	299.5

Thus, as a large-scale consumer of benzene, maleic anhydride has come well within the realm of petrochemicals. In the years ahead, its dependence on petroleum-derived benzene will increase, as will that of other benzene consumers. Meeske[3] estimates that the benzene take for maleic anhydride production in 1956 will exceed 1955 requirements by ten per cent.

Maleic Anhydride Processes

The air oxidation of benzene to maleic anhydride (Equation 1) is carried out commercially in the presence of catalysts based mainly on vanadium pentoxide on an alumina carrier. The catalyst is a modification of that employed for the production of phthalic anhydride from napthalene or o-xylene (a discussion of industrial phthalic syntheses has been presented by the author elsewhere[4].

The processes differ significantly, however, in reaction conditions. This difference is called for by the greater refractiveness of benzene to oxidative attack which makes it necessary to operate maleic plants at more drastic conditions and at lower yields. In maleic production, yields of 50-60% of theory are normal, while phthalic producer looks to yields of 86-88% of theory.

The similarity ends quite completely at the converter outlet between phthalic and maleic anhydride manufacture. Because of its higher volatility and extreme corrosiveness, recovery and purification of maleic anhydride calls for engineering techniques which differ substantially from the relatively simple methods employed by the phthalic manufacturer.

The difference in benzene and naphthalene's susceptability to air oxidation is illustrated strikingly in Fig. 1, based on data by Mars and Van Kre-

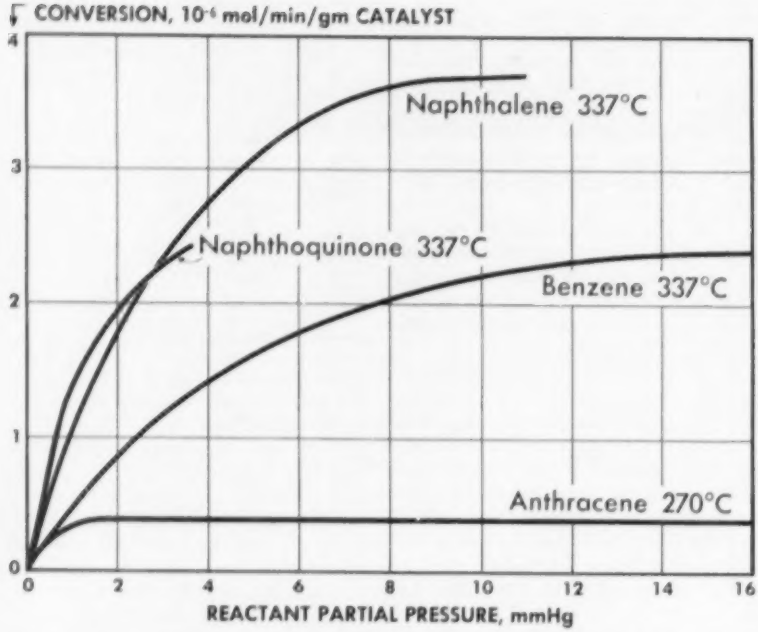


Fig. 1—**CONVERSION BY AIR OXIDATION** of benzene, naphthalene and anthracene as a function of reactant partial pressure.

velen[5]. Conversion rate is seen to increase with the feed hydrocarbon's partial pressure until an asymptotic value is reached. These are gross conversion rates over the same catalyst. It will be noted that the runs with benzene were carried out at 377°C vs. 337°C for naphthalene. Despite the higher temperature, benzene conversion rate is substantially below that observed for naphthalene.

Therein lies the main reason why yields of maleic anhydride are so far below the yield obtainable in the manufacture of phthalic anhydride. At the more drastic conditions called for in the conversion of benzene, the desired product is less stable, more easily degraded by decomposition and oxidation reactions. Maleic, like phthalic anhydride is, of course, only a semi-stable intermediate in the total combustion of the feed hydrocarbon. Yield of the desired product is determined by the relative rates of its formation and its degradation.

The ideal catalyst for maleic anhydride production has maximum accelerating effect on the conversion of benzene, and minimum effect on the further oxidation of maleic anhydride. Oxidation conditions, too, should ideally be adjusted to this objective. Commercial practice represents an economic compromise, dictated by the relative cost of raw material and operating expense.

Typical of process flow in a modern maleic anhydride process is the scheme employed at the Elizabeth, N. J., plant of Reichhold Chemicals, Inc.[6] Air and benzene are preheated separately and the vapors joined, in carefully controlled ratio, at the converter entrance (in the fixed-bed, tubular converters which are universally employed at this writing, the flow through the reactor is in a downward direction). Within the reactor, the temperature is controlled at 400-450°C, using (at Reichhold's plant) fused salts as cooling medium to remove the exothermic heat of reaction.

The reactor effluent is passed through a knock-out pot and the gaseous phase then enters a set of heat exchanges, followed by scrubbers. At the original Elizabeth plant, water serves as scrubbing medium. In the course of this treatment, contained maleic values are hydrolized to maleic acid. The rich absorber liquor is evaporated; the organic concentrate is dehydrated to crude maleic anhydride. This product is fractionated for recovery of refined maleic anhydride, which is flaked and, where needed, pelletized and bagged, ready for shipment.

A recent expansion at this plant has been reported[7] to embody a novel process developed by Scientific Design Co. While details have not been released, it may be speculated that the main point of difference is the use of dibutyl phthalate in lieu of water as scrubbing medium in the recovery stage. This approach has the advantage of yielding maleic anhydride directly, i.e., without need for intermediate hydrolysis and dehydration for the major portion of the product.

This process, along with other variants in recovery methods and dehydration processes, will be discussed below, following consideration of process aspects in the reaction stage.

The Benzene Oxidation Step

Successful execution of the partial combustion of benzene to maleic anhydride has necessitated the solution of formidable engineering and operating difficulties.

The reaction is highly exothermic. Partial oxidation of benzene to maleic anhydride evolves 10,500 Btu per pound hydrocarbon. Total combustion of one pound benzene liberates 18,000 Btu. Thus, the conversion of benzene to maleic anhydride, in 50% yield, which is within typical operating range, must cope with the evolution of 14,250 Btu per pound benzene usefully converted, or 22,600 Btu per pound product.

A large excess of air, for reasons which will become apparent later, is used in the reaction (typical range is 26 to 50 pounds air per pound benzene). Such dilution is helpful in handling the exothermic heat of reaction, but sensible heat of the process stream is not enough to keep operating temperature within the range held permissible by reason of product stability and safety to the catalyst.

It is, therefore, essential that means be provided for the adequate removal of heat from the reaction zone. Here, design methods follow the systems employed for partial oxidation of naphthalene.

Shell-and-tube converters are used in existing installations. The catalyst is mounted inside the tubes, which are surrounded by a suitable heat exchange medium. Mercury, boiling under pressure, is employed for cooling purposes in some units. The low wetting ability of pure mercury detracts from its value as heat exchange medium, however, and amalgams with sodium are used to overcome this handicap.

Very accurate control can be effected in mercury-cooled converters by adjusting the pressure applied to the heat exchange medium. The use of boiling mercury offers further advantages: the medium is liquid over a wide range of temperatures and has a relatively high heat of vaporization (117 Btu/pound).

These benefits are largely offset by

the high toxicity of mercury and by the large amount of capital which must be tied up in mercury inventory. Recent years have therefore seen a distinct trend in favor of alternate coolants, notably molten salt mixtures and Aroclors.

A typical commercial salt-cooled converter in oxidation service has been described by Sherwood[4]. This unit is of modified shell-and-tube design. Its 2944 one-inch tubes are packed with 5-mm pelleted catalyst. The tubes are surrounded by molten nitrate-nitrite bath which is circulated inside the converter by means of a turbine-type agitator. The reactor is provided with an external jacket and a centrally located tobe bundle through which cold air is blown for the removal of heat from the salt bath.

To achieve optimum conversion in fixed-bed converters of this type, steps must be taken to provide uniform distribution of the reactor gases through the tubes by properly adjusting the pressure drop. While each tube contains the same amount of catalyst, compensation for differences in pressure drop may be made at the time the converter is packed, by placing different depths of small quartzite granules above the catalyst.

The reaction system should be free of iron oxide, which promotes complete combustion to carbon dioxide and water. However, for economic reasons, carbon steel tubes are generally employed in preference to alloy steels. Precaution must therefore be taken at the time the tubes are filled with catalyst to ensure that any adhering rust is removed.

A fluidized-bed technique for the highly exothermic partial oxidation of benzene is a naturally attractive idea. Among the advantages of this application have been cited:

1—The characteristic high heat transfer coefficient of fluidized-bed systems permits more uniform temperature control than is possible in fixed-bed catalysis where the low transfer rate from gas phase to tube wall is controlling.

2—The good thermal efficiency of fluidized-bed oxidation in which the abstracted heat serves for the generation of steam.

3—The amenability of the fluidized-bed system to operation at higher hydrocarbon content in the feed gas than is possible in fixed-bed systems. The reason for this difference is the reported ability of finely divided catalyst to break up explosion waves, thus permitting operation slightly above the explosive limits.

Fluidized-bed techniques are not now employed for the commercial manufacture of maleic anhydride, but are in use at two large phthalic anhydride plants. Deterrent to application of these techniques for maleic production has been the relatively small plant size and the formidable difficulties which were encountered during early work with fluidized phthalic plants.

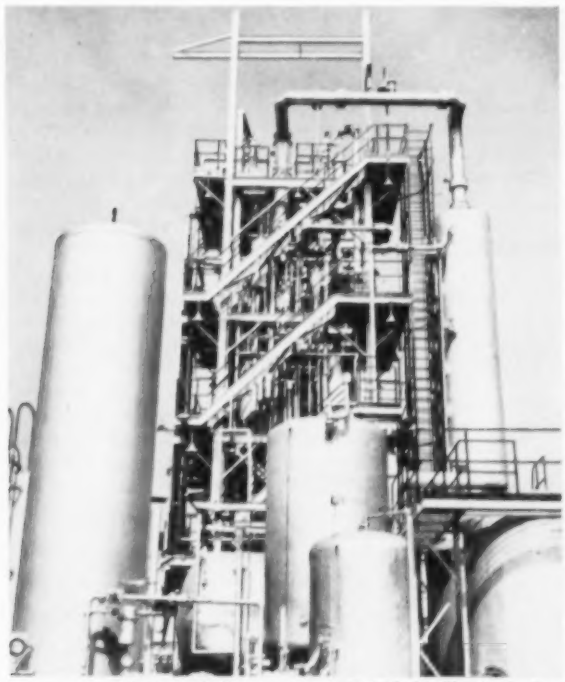
Reaction Variables

Reaction conditions subject to control are: preparation of catalyst, air/hydrocarbon ratio, space velocity (which determines the contact time in the converter), and operating temperature. The reaction is carried out at 1-5 atmospheres (generally at 1 atmosphere) and on once-through conversion basis (i.e., without recycle).

Catalyst Composition

Much of the early work in benzene oxidation was carried out over V_2O_5 catalyst applied by some coating technique to a carrier such as alundum. This is also the catalyst preferred in American technology for phthalic manufacture. (Another phthalic catalyst, consisting of V_2O_5 and K_2SO_4 impregnated into silica gel, is not considered applicable to industrial maleic anhydride synthesis.)

Special catalysts were developed in



Photograph by courtesy of Reichhold Chemicals, Inc.

MALEIC ANHYDRIDE MANUFACTURING FACILITIES of Reichhold Chemicals, Inc., at its Elizabeth, N. J., plant.

Photograph by courtesy of Reichhold Chemicals, Inc.

CONTROL ROOM for maleic anhydride unit at Reichhold Chemicals, Inc., at its Elizabeth, N. J. plant.

later years for maleic anhydride production. These differ from the coated oxidation catalyst for phthalic service principally in the choice of modifier. Most particularly, molybdenum oxide has been found to be a useful promoter for vanadium pentoxide catalyst in benzene oxidation service. Typically, such a phthalic acid oxidation catalyst will contain 11.6% V_2O_5, and 4.16% MoO_3 on alundum base.

Porter[9] claims that the oxidation reaction is moderated and maleic anhydride yield increased by incorporating into the catalyst P_2O_5 in the amount of about 0.4 mole % of the V_2O_5 (for atmosphere pressure oxidation, larger concentration for higher pressure operation). The catalyst material (in the coating, as distinct from the carrier) must be free of alkali metal compounds.

This P_2O_5 moderation effect is illustrated by the data in Table 3. In the underlying tests, the catalyst support was 6 to 10 mesh alundum.

This catalyst modification lowers overall reaction rate. To overcome this objection, Porter proposes that the reaction be carried out in 2 stages. In the first stage, 60-70% of the benzene is converted over standard catalyst. The P_2O_5-modified catalyst is used in the second stage where maleic anhydride concentration is high, and losses of product are, therefore, greatest.

Fixed-bed catalyst particle-size is critical according to Darby [10]. Thus, pellets of 0.22 inch diameter gave only 80% of the yield of maleic obtained at comparable conditions over catalyst particles of 0.16-inch diameter (and equal length).

Air/Hydrocarbon Ratio

Theoretically, the partial oxidation of benzene to MAA calls for 106 SCF air per pound benzene. Actually, a very much larger ratio must be employed. There are several reasons for this.

Primarily, it is necessary to operate at hydrocarbon concentration below the explosive limit, which is reported at one pound benzene per 26 pounds air.

Secondly, a look at Fig. 1 shows that very much better conversion rate is obtained by raising the air/hydrocarbon ratio. Yield, too, is improved and catalyst stability is maintained. In his early work, Weiss[11] showed that V_2O_5, the effective catalyst principle, is reduced to V_2O_4 configuration persists of benzene and air, but that a stable V_2O_5 configuration persists at air/hydrocarbon ratios exceeding 14. Above this value, the ratio of complete combustion products to partial combustion products remained substantially constant, while lower air ratio actually lessened the formation of desired product.

Setting the air/hydrocarbon ratio's upper limit are economic consideration in air compression and product recovery from more dilute reactor make gas.

The practical operating range is considered to be between 26 and 50 pounds air per pound benzene.

Temperature

At a given set of conditions, yield in partial benzene oxidation passes through a definite maximum as the temperature is raised. At temperatures below this point, conversion is slow and incomplete in the contact time allotted. In a single-pass operation such as maleic synthesis, this means low ultimate yield.

Above the optimum temperature, too much complete oxidation occurs at the expense of maleic anhydride yield.

The proper temperature level depends on a number of other variables, above all on catalyst preparation and age, on air/hydrocarbon ratio, and on space velocity. Most particularly, the temperature of the system must be raised as the catlyst age advances. The best temperature is a direct function of space velocity; i.e., high space velocity (= low contact time) calls for high operating temperature.

In maleic anhydride production, higher operating temperature is called for than in phthalic synthesis. The usual operating range in maleic anhydride plants is between 400 and 450°C. Fig. 2 shows the significant improvement in maximum yield and reaction stability when the temperature is raised from 375° to 400°C[20].

Space Velocity

Space velocity, the inverse of contact time, is a prime variable in maleic synthesis. Its proper level depends on technical variables (catalyst activity and temperature) and on market considerations.

When maximum maleic output is the principal concern, high space velocity is called for. To compensate, a boost must be taken in reaction temperature.

On the other hand, operation for more moderate output, as a proportion of plant capacity, permits lower space velocity and temperature, resulting in better overall utilization.

A quantitative effect of space velocity at two temperatures is shown in Fig. 2, based on work by Hammar[20]. Yield is seen to pass through a maximum value in each case, as one would expect. At low space velocity, sufficient contact time is given the reaction system for oxidation of maleic anhydride, which has been formed, and for other reaction chains, all of which result in complete combustion of benzene.

Very high space velocity, on the other hand, does not allow enough time for maximum benzene conversion, and an excess of unconverted hydrocarbon is found in the reactor make gas. In a single-pass process, such as maleic anhydride synthesis, reduced conversion is tantamount to depression in ultimate yield.

Table 3—Effect on Maleic Anhydride Yields by Incorporating P_2O_5 into V_2O_5-MoO_3-Alundum Catalyst

Test No.	Days	Catalyst Temp., °C	Benzene Conc., %	Space Velocity	% Benzene Attacked	Mols MAA/100 Mols C_6H_6 Attacked
A-1[1]	4.5	475	1	6,000	56	65
A-2	50.0	475	1	6,100	73	66
A-3	115.0	475	1	6,100	62	68
A-4	2.7	525	1	12,000	63	65
A-5	57.0	525	1	12,200	48	68
A-6	103.0	525	1	12,200	60	67
B-1[2]	40	475	1	6,100	70	70
B-2	80	475	1	6,100	69	70
B-3	109	475	1	6,100	58	70
B-4	5.7	525	1	12,200	64	68
B-5	50	525	1	12,200	72	68
B-6	105	525	1	12,200	66	68

(1) Catalyst: 11.6% V_2O_5, 4.16% MoO_3 for tests A-1 through A-6.
(2) Catalyst: 11.4% V_2O_5, 3.9% MoO_3, 0.034% P_2O_5 for tests B-1 through B-6.

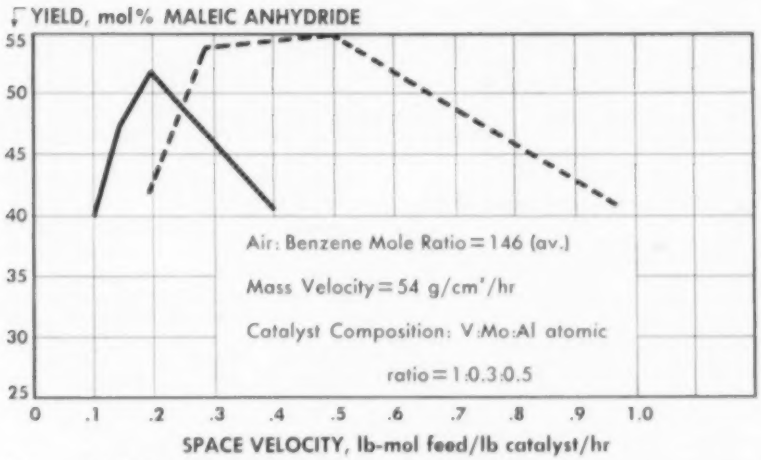


Fig. 2—**MALEIC ANHYDRIDE YIELDS,** by air oxidation of benzene, versus space velocity and temperature (solid line 375°F, dashed line 400°F).

Product Recovery

Because of the large amount of excess air which is required in partial oxidation of benzene, product concentration in the reactor make is very low and its recovery imposes a special problem.

A typical reactor gas will contain 1.0 vol% maleic anhydride, 8.6% oxygen, 8.0% carbon dioxide, 5.0% water, and 77.4% nitrogen. In most installations, this mixture is cooled to 100-150°C in indirect heat exchangers, at which temperature the gas is passed to a packed water-scrubbing tower. The scrubbing medium in this column is recirculated to build up its maleic acid content. The acid is converted to anhydride by means to be discussed.

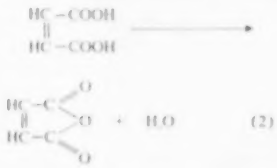
This process continues to be economically useful, despite its drawbacks; namely, the need to go from maleic anhydride to maleic acid and back to the anhydride, and the deposition of tars in the primary indirect heat exchanges which makes a clean-out necessary every few days.

To overcome fouling of heat exchangers, Nachod[12] quenches the reactor make gases by a direct water spray which lowers the temperature to a level just above the dew point of the gases with respect to maleic anhydride. In effect, this means cooling to 85-90°C. At this temperature, there will be, of course, an aqueous phase which contains a substantial amount of maleic acid. Following phase separation, the cooled gases are taken to a standard water scrubber. Table 4 shows recovery data obtained by Nachod in such a system.

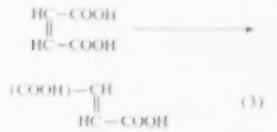
The disadvantages of spray quenching are the introduction of more water than is necessary in a conventional system, which must be evaporated in a subsequent step, and additional equipment which is exposed to highly corrosive aqueous maleic acid.

Dehydration of Maleic Acid

The absorption of maleic values in water yields maleic acid which must subsequently be reverted to maleic anhydride. Aside from thermal considerations, a problem in this dehydration step is the tendency of maleic acid to isomerize to fumaric acid. Thus, the desired reaction



is accompanied by the yield-consuming side reaction



We differentiate three types of process which will yield maleic anhydride from maleic acid: thermal dehydration, extractive distillation and fractional crystallization.

Thermal dehydration is the customary practice. Maleic acid is evaporated, substantially to dryness, and is then flash-vaporized. In the course of vaporization, the acid is decomposed into maleic anhydride and water vapors. Such decomposition is aided by the use of sub-atmospheric pressure.

The mixture is condensed in two steps. In the first stage, carefully controlled at elevated temperature (approx. 70°C), the bulk of maleic anhydride is separated. Further cooling in a second heat exchanger effects condensation of most of the remaining maleic values as maleic acid. The off-gases from this second stage are water-scrubbed prior to venting through the steam jet which maintains reduced pressure in the entire dehydration system.

Design of the flash vaporizer must make allowance for the continuous removal of residual materials which will foul the heat exchange surface. One solution, proposed by Crowell[13], is the use of an externally heated rotating drum which is filled with

Table 4—Recovery of Maleic Acid in Water Spray Quenching System

Run No.	% Conversion of Benzene	Spray Condenser Pressure, psig(1)	Gas Temp. Before Spray, °C(1)	Gas Temp. at Separator, °C(1)	Total Liquor from Cond., lb	Total Liquor from Scrub., lb	Total Maleic Acid from Spray Cond., lb	Total Maleic Acid from Liq. Scrub., lb	Total Maleic Acid Recovered, lb
1	45.5	29.0	444	90	749	362	156	128	284
2	36.4	28.5	446	85	380	318	135	100	235
3	48.5	29.0	449	88	426	369	147	136	283
4	35.7	29.0	478	86	454	418	148	157	305
5	30.5	30.0	423	87	435	225	141	75	216

(1) The data are averages for 8-hour runs.

tumbling elements (iron bars, etc.) to scour the walls continuously.

Dehydration is effected in this drum at 100-200 mm Hg abs. and between 160 and 200°C. In operation at 150 mm, the off-gases are first cooled to 70°C, whereby 94% of the maleic anhydride present in the vapors is condensed as a product consisting of about 98% maleic anhydride and 2% maleic acid. Maleic anhydride purity may be raised by operating the first condenser at higher temperature; its yield is improved, at the cost of purity, by taking the primary condensation below 70°C. The remaining maleic values are recovered in a second condensation stage.

An alternate approach which is claimed to result in less fumaric acid formation involves flash dehydration from a heavy oil in a system reminiscent of extractive distillation. In a process, due to Weiss,[14] maleic acid is fed, either dry or in strong aqueous solution, to a xylenes mixture containing 40-70% maleic anhydride.

The mixture is circulated at a rate which will keep it in the contact chamber for 30 seconds to 2 minutes. Temperature in the chamber is approximately 200°C. Water vapor is released overhead. A bleedstream of the circulating solvent is taken continuously and is distilled for separation of xylenes from crude maleic anhydride.

Finally reference must be made to a process[15] in which maleic anhydride is recovered directly by fractional crystallization from strong (65%) aqueous maleic acid solution. Based on available phase diagram data, this separation is technically feasible.

Means to Minimize Hydrolysis

The need to go through the maleic acid stage in the course of anhydride recovery is an obvious annoyance, and means have been sought to avoid or at least minimize the extent of required hydrolysis. There are three general approaches to this problem: dephlegmation of the reactor gases, use of organic solvents as scrubber medium, and recovery by adsorption.

Dephlegmation (i.e., partial condensation) cannot, of course, provide complete recovery of maleic anhydride, but it offers a means to minimize the amount of maleic acid formation. The gas emanating from the dephlegmator would still have to be scrubbed with water, but only a part of the total maleic values will enter the water phase. This portion of the product must, of course, be upgraded to maleic anhydride in the manner outlined above. The combination of dephlegmation and water scrubbing of the residual gas has been reported in commercial use.

Miller[16] pointed out that maleic anhydride does not react with water *vapor* contained in the reactor gas. It is possible, therefore, to recover maleic anhydride directly by cooling the converter gas below the condensation temperature of the maleic anhydride, but above the dew-point of water vapor contained therein. The condensation should be below the freezing point of maleic anhydride (52-53°C) so that no liquid phase is formed. In such a process, the possible recovery (at 100% condenser efficiency) is determined by the equation:

$$\text{Possible recovery} = 100\,(1 - RV/2.25C) \quad (4)$$

where:

Possible recovery = percentage of maleic anhydride actually present in the exit gas mixture which can be condensed by this method.

R = ratio, by weight, of bone-dry air to benzene in incoming gas mixture.

V = vapor pressure of maleic anhydride in mm at the temperature of condensation.

C = conversion factor expressed as pounds of maleic anhydride per 100 pounds of benzene.

For practical purposes, actual recovery of anhydride by this method is

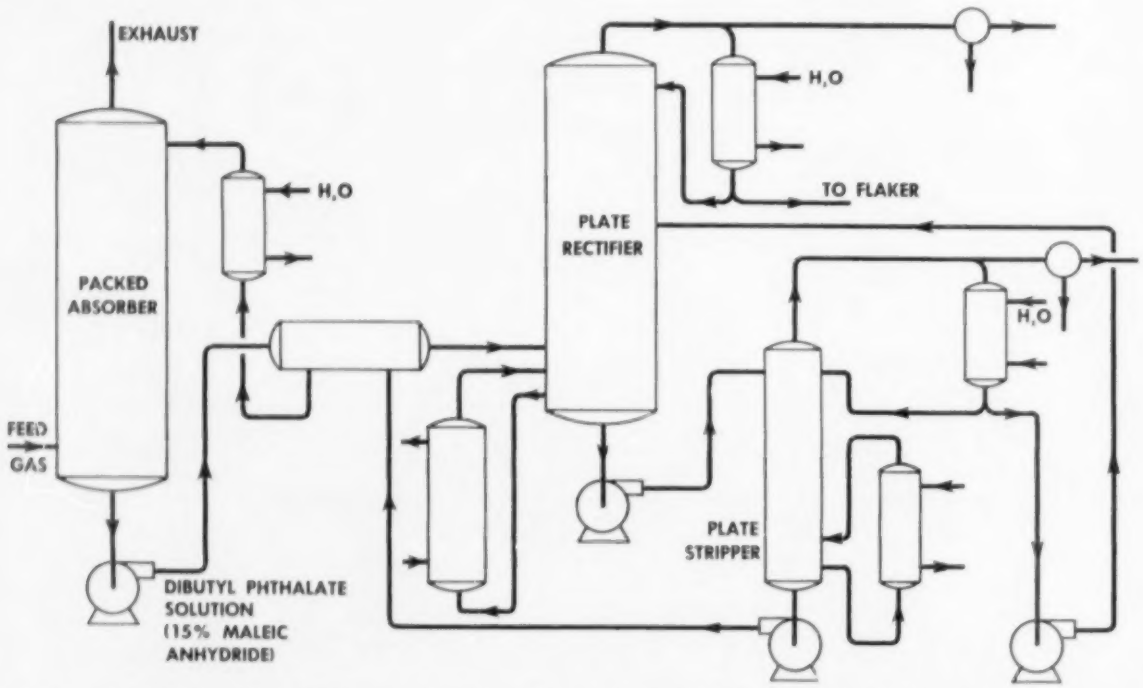


Fig. 3—**MALEIC ANHYDRIDE RECOVERY** process by Landau uses dibutyl phthalate to scrub reaction gases.

limited to 60-65% of initial maleic content.

Absorption in organic solvents has been variously proposed in lieu of the water scrubbing step to eliminate hydrolysis entirely. Such processes call for solvent recovery and purification facilities. Furthermore, there is the hazard of forming an explosive mixture of the solvent with oxygen in the converter gas.

Punnett[17] calls for a solvent such as alpha-chlornaphthalene in which maleic anhydride is soluble, but with water is immiscible. Absorption is carried out above the dew point of contained water, typically at 45°C, and maleic anhydride is recovered from the saturated solution by crystallization at 3°C.

More recently, Landau[18] has covered the use dibutyl phthalate as scrubbing medium for converter gas at temperatures at which maleic anhydride is still completely in the vapor phase.

Aside from its advantageous solubility characteristics, dibutyl phthalate is favored by low vapor pressure and excellent thermal stability up to 250°C. This facilitates its distillative separation from absorbed maleic anhydride. Furthermore, chemical stability of dibutyl phthalate almost voids the risk of explosiveness.

Fig. 3 illustrates the recovery system for maleic anhydride, using dibutyl phthalate as scrubbing medium. The reactor gas is precooled and contacted with solvent in the absorber column at 42°C. Scrubbing medium is recirculated around the column to permit build-up of maleic anhydride concentration to 15 weight per cent.

A bleedstream is drawn off to the plate rectifier. Here, bottoms temperature is taken to approximately 200°C. Top pressure is 5 mm Hg abs., bottoms pressure is about 20 mm. Maleic anhydride, removed overhead, is condensed as liquid and taken to a flaker as last step prior to processing.

Solvent bottoms from the plate rectifier are passed to a stripper, operated at 210°C and 5-10 mm Hg abs. The overhead from this column is returned to the plate rectifier. Stripper bottoms are cooled and recycled to the absorber.

Another process considered for recovery of maleic anhydride from reactor gas involves adsorption (e.g., on activated charcoal), followed by vacuum desorption at elevated temperature (250°C). Recovery efficiency of 97-98 per cent is claimed[19].

Regardless of the process employed for recovery of maleic anhydride, final vacuum fractionation is needed to upgrade maleic anhydride to market specifications. (In the Landau process, this step is combined with solvent recovery in the plate rectifier.) This final distillation step offers no special process problems and is carried out by conventional means.

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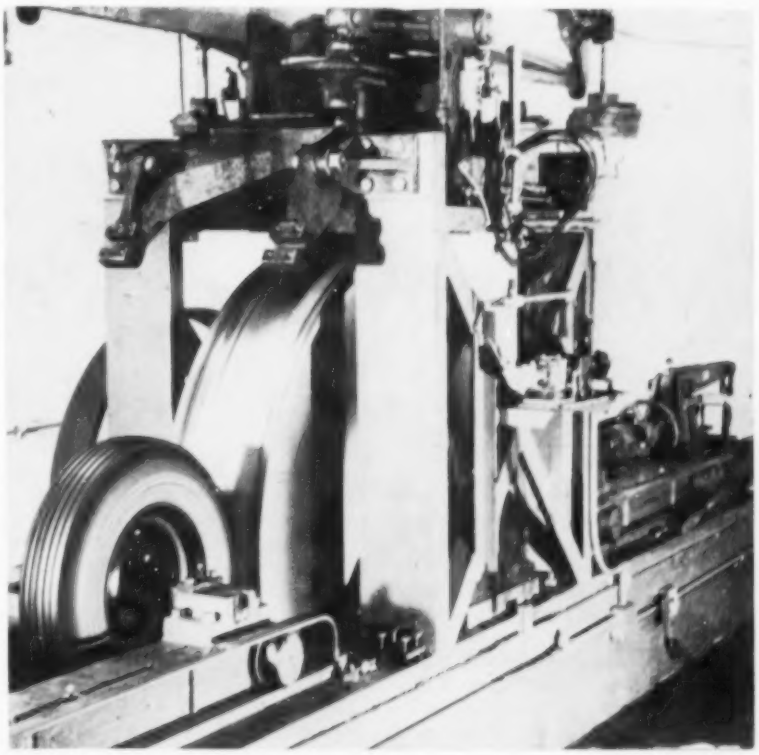
NEWS in VIEWS



THE TORTURE TEST—a rugged obstacle developed to check wear qualities of the new all-butyl automobile tire now being pilot-staged by Esso Research & Engineering Co. (see Tomorrow, this issue, p. 15). The machine shown above is at the Armstrong Tire Co. in West Haven, Conn.

1 UNLOAD lube gun (Rockwell "Hypregun"). Compressor in truck is on.

2 UNREEL air hose. Reel is air powered to save reeling time.

3 CONNECT hose to gun. Gun is also hooked to valve buttonhead.

In six quick steps

Valve Servicing the Mobile Way

VALVE maintenance is a fast-moving operation at Richfield Oil Corp.'s four natural gasoline and compressor plants in California's San Joaquin Valley. A company service man visits the 15,000 plug valves in a specially designed maintenance truck at intervals of from two weeks to six months.

Since the program began seven months ago, the truck has traveled some 2,000 miles between the plants at North Coles Levee, Wheeler Ridge, and the two at Cuyama Valley. Valves in heavy use, say compressor suction and discharge valves, are visited every two weeks. Others, like block valves on a main line, are in the six-month circuit.

The truck is a self-contained maintenance department. Main items are a 2-stage compressor and the "Hypregun," the name of Rockwell Manufacturing Co.'s lube gun. The 20 cu ft compressor develops 150 psi working pressure and is driven by a 4-cylinder Waukesha engine. The lube gun works under 15,000 psi.

Accessory equipment consists of an air hose (which is air powered, to save reeling time), several cans of lubricant, tools (including a complete set of box end and pipe wrenches), buttonhead fittings, miscellaneous parts for the Hypregun, a vise, a 10-ft extension ladder and step ladder, water can, and kits for first-aid and snake bite. The truck itself is a 1955 Dodge Route Van (Model DU 102) with an 84-in. panel body.

The operator can give all normal maintenance services. If a valve needs to be pulled and cleaned, he does it. If pulling it out would mean a plant shut-down, he marks the valve and waits for a scheduled shut-down.

Costs work out like this:

Truck	$3,050
Work bench, vise, air hoses, reels and grease line	500
Compressor	800
Total	$4,350

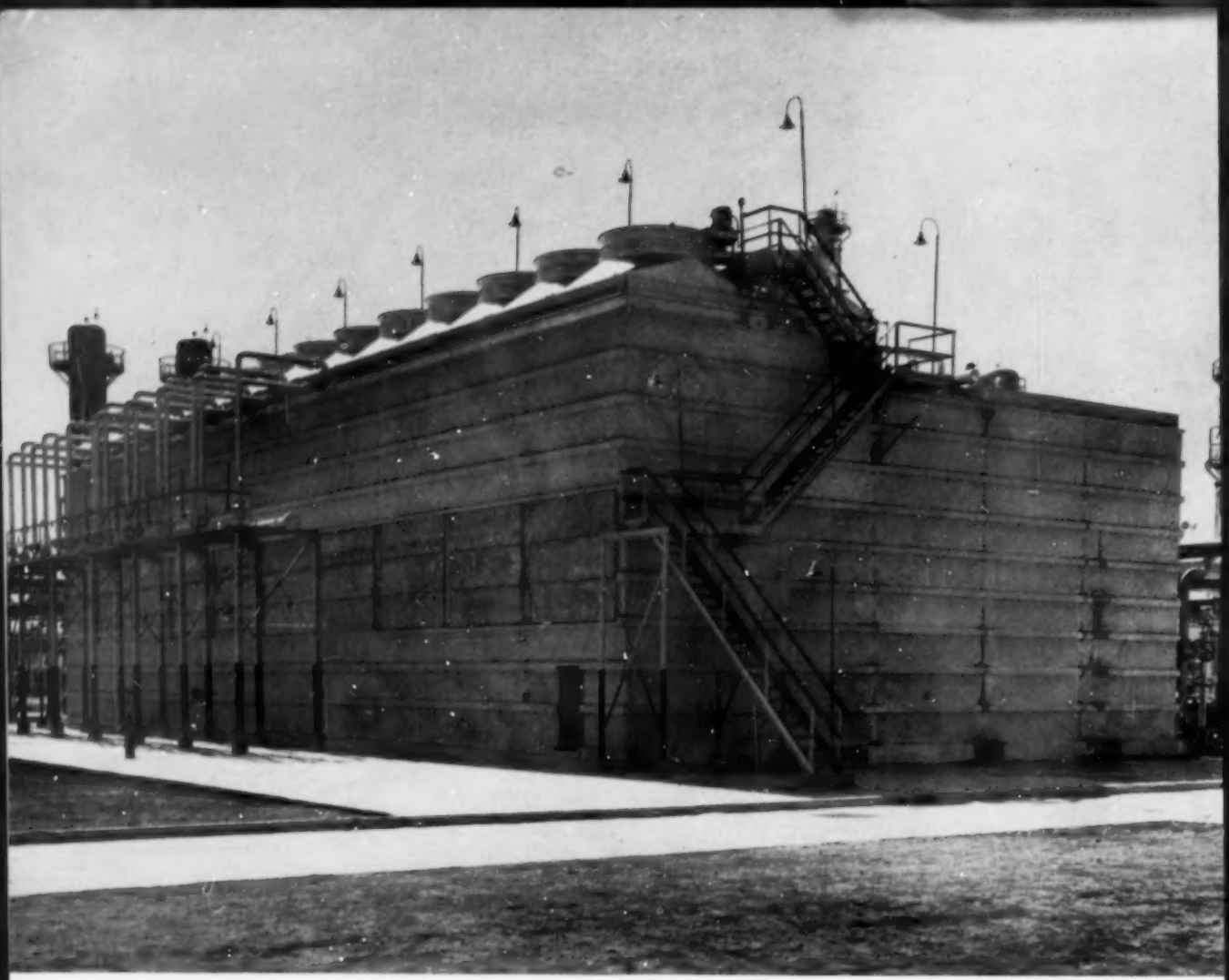
The total includes outfitting expenses.

It's hard to measure the value of preventive maintenance in dollars and cents. It's always a question of what might have happened if you hadn't done it. But Richfield believes that this maintenance will pay off, and points to the fact that in seven months no valves have broken down in the four plants.

4 LUBE AWAY! Here valve is a Nordstrom plug valve on a 4¼ x 8 in. Union triplex pump that circulates absorption oil to a high-pressure absorber.

5 CLEAN AND INSPECT plug valve when it's possible to pull the valve out without shutting the plant down.

6 REPLACE PARTS from the supply of fittings in the mobile truck whenever necessary.



CONSTRUCTION COSTS ARE LOW, concrete is plentiful, redwood scarce. That's why . . .

Gasoline plant in Old Mexico said yes to . . .

All-Concrete Cooling Tower

WELL, IT'S ALMOST all-concrete. Only the tower packing, mist eliminators, and intake louvers are redwood.

But the rest of this tower, built for Petróleos Mexicanos' new 300,000 mcfd Reynosa, Mexico, gas processing plant, is made of precast concrete columns, beams, distribution basin, and curtain wall slabs.

Concrete wherever possible was the goal of Hudson Engineering Corp. of Houston, designers and builders of the unit now carrying most of the cooling load at the recently completed plant.

By RONALD E. CANNON
Southwestern Editor

Why concrete? In the first place, structural redwood is not plentiful in Mexico. Cement is, and Pemex tries to use native materials wherever possible. Secondly, labor costs in that country are such that a reasonable first cost is possible with concrete, though probably 30-40% higher than that of conventional construction.

After hurdling the mental block of higher first cost, other advantages of all-concrete construction begin to look attractive:

1—Concrete construction makes a practically maintenance-free installation.

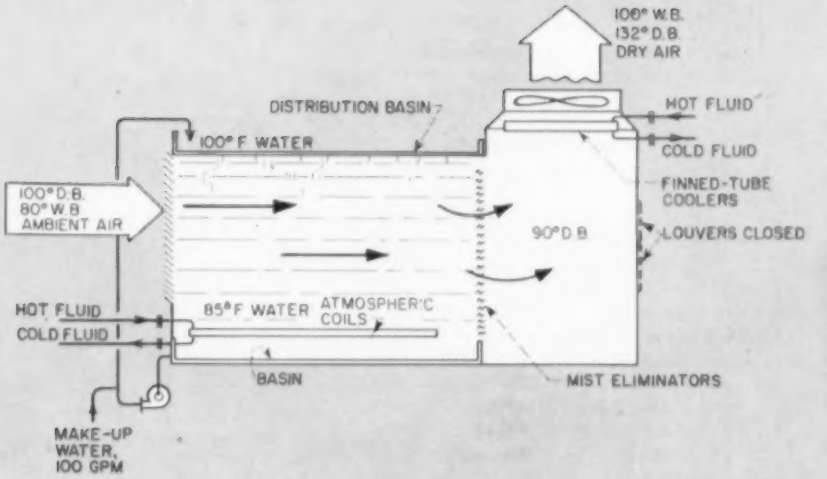
2—Durable materials make a long-lived tower—estimated to be life of the plant. Redwood non-structural parts may require periodic maintenance.

3—Concrete is impervious to fungous attacks and rot.

4—Structure is fireproof.

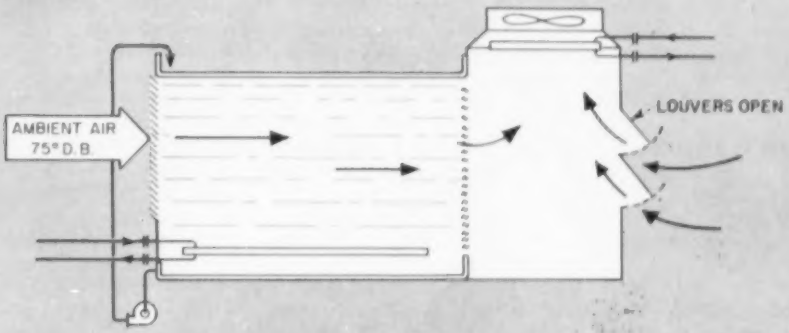
5—Concrete is resistant to all common water treatment chemicals.

6—The structure is less vulnerable to wind and storm damage.



SUMMER OPERATION

All air is pulled through packed section, which contains conventional redwood water distribution trays, over which water falls from the tower top to basin below



WINTER OPERATION

When temperature of air to finned tube coolers falls to 65-70°F, louvers open. Air circulation through packed section is reduced, cutting water evaporation and holding cooling rate

Fig. 1 (above), **Fig. 2** (below)—How the unit works

How the Unit Works

The tower is a two part design, combining a cross-flow cooling tower with a finned-tube aerial cooler. This is a standard Hudson design known as the "Combin-Aire Unit, which makes maximum use of air cooling with minimum water consumption.

Although the design has wide acceptance in gas processing plants and refineries, a brief description of its operation is in order:

The tower has two sections—a packed section and a dry section (Fig. 1). The packed section has conventional redwood water distribution trays over which water falls from the top of the tower to the basin section below. On its way through the trays, the water is subjected to a cross flow of ambient air induced by fans in the dry section of the tower.

Air flow cools the circulated water —in this plant to about 85°F, which represents a 5° approach of the design wet bulb temperature of 80°F under full load summer design conditions. The cold water then falls over atmospheric (exposed bare tube) type heat exchangers in the bottom of the wet section—increasing its temperature in the heat exchange to about 100°F. Hot water is then recirculated from basin back to trays.

Air pulled through the packed section passes on to the dry section of the tower. Redwood mist eliminators between wet and dry sections remove all entrained water, leaving humidified air of about 90°F (dry bulb).

This cooled air, reduced from an ambient temperature of about 105°F, is then used in a fluid-to-air heat transfer as it passes over finned-tube heat exchangers located at the fan inlet. Fans and coolers are also standard Hudson designs.

Each combination unit has a single packed section and a dry section with two fans each. Pemex's Reynosa installation is made of 14 such units with a common distribution basin and a single precast concrete shell. Design water circulation is 6,000 gpm at full summer load. The tower has a heat load of 45,000,000 Btu/hr on the water side. Heat load in the finned-tube section is 52,556,000 Btu/hr. Total plant heat exchange is in excess of 97,500,000 Btu/hr.

Fans are 8-ft diameter, four-bladed, and Vee-belt driven by 10 hp explosion-proof motors. The 28 fans circulate a total of 1,534,000 scfm or 54,000 scfm each. Blade pitch can be varied manually to adjust for varying operating conditions.

Additional adjustments to ambient temperature changes are effected by louvers in the dry section. These louvers open automatically on a decrease in air temperature in the dry section, partially by-passing the packed section and hereby minimizing evaporation of scarce water (Fig. 2). Louvers are operated by air-powered damper controls. The by-passing action takes place when air to the finned-tubes reaches 65-70°F.

(Continued on next page)

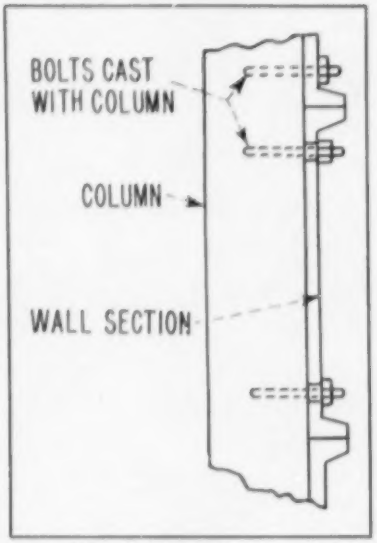


Fig. 3—**BEAM-TO-COLUMN** connection in plan view showing typical construction

How It was Built

Lifting and holding together some 180 cubic yards of precast concrete in over 400 sections is a job calling for minute planning and exacting field control. Field forces worked from carefully prepared detailed drawings that simplified field routine and speeded erection time.

The lower basin was poured in place as in any conventional cooling tower construction. Over-all dimensions of the lower slab are 122-ft 4-in. by 61-ft 3-in, including the floor of the dry section. The basin itself is 35-ft 6-in. by 122-ft 4-in. with 4-in. thick, 2-ft high walls. Basin floor is reinforced with ½-in. reinforcing steel on 12-in. centers, while the dry section floor has 8-ga reinforced wire mesh. Piers are supported by reinforced beams poured with the slab.

Concrete yardage in the foundation basin, floor, and sumps, totaled 250 cu. yd. This was the only portion of the all-concrete structure that was poured in place.

Columns are, for the most part, 10 by 10-in. square and range in length from 28½-ft to 31½-ft high. They were precast at the job site and erected in place. Column-to-foundation pier connections are made by means of base plates cast into the base of the column at the time of pouring. These base plates are galvanized steel and fit over galvanized anchor bolts poured with the foundation piers.

Connecting bolts for attaching the thin concrete curtain wall sections were set into the columns when poured and placed to project through sleeves in the wall slabs (Fig. 3).

Column-to-beam connections were made by welding together flat connection plates imbedded in both beam and column at time of casting (Fig. 4). These joints were later grouted for protection against corrosion.

Fifty-five columns were required for the structure. The major loads are the distribution basin, fans, and finned-tube exchangers. No diagonal bracing is used in the structure.

Beams, all 158 of them, were also precast and erected in place. Again, all connecting parts were provided with galvanized bolts when the beams were poured. In addition to the top, load-carrying beams, there are intermediate beams about midway up the tower, which serve as bracing and as lower supports for water-side trays.

Distribution basin and roof deck was lifted up in 60 sections, each about 6 by 12-ft. The slab is 4-in. thick. The 1-ft-high walls of the basin were poured integrally with the outside sections of the basin floor.

Brass ferrules through the floor of the basin floor provide even distribution of water over tower trays. Joints between sections were grouted water tight after the sections were in place.

Wall sections are 2-in. thick channel sections, precast with 6-in. reinforcing ribs, or flanges, on the long dimension. The complete shell of the installation required a total of 124 wall sections, each 3 by 12-ft, plus 20 sections 3 by 24-ft. They are connected to the structural columns by simply placing over bolts poured with the columns and bolting down.

Total concrete in the complete job is 425 cu yd, of which about 175 cu yd was precast and erected in place. Cost of concrete "in place" ran about $75/cu yd for the precast section. Usual figures will apply to the portion formed and poured by conventional methods.

Timetable for construction was worked into the regular schedule, and the complete tower was finished in about three months.

Fans and aerial coolers are mounted as units on galvanized steel structural members atop the uppermost load-carrying beams. Standardization played a big part in the selection of fan, coolers and drives—all fans and drive parts are interchangeable throughout the plant. Finned-tube coolers are interchangeable except for tubes that might be of dissimilar metals for various process streams.

Tower packing, or water distribution trays, is supported from the top

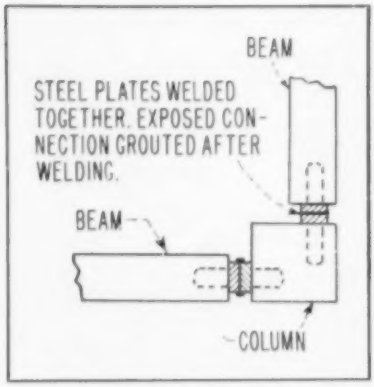


Fig. 4—**WALL-TO-COLUMN** connection in elevation showing typical construction

beams and hangs down almost to the atmospheric coolers below. Redwood timbers bolted to main concrete members with brass bolts provide a framework on which to support the individual tray sections.

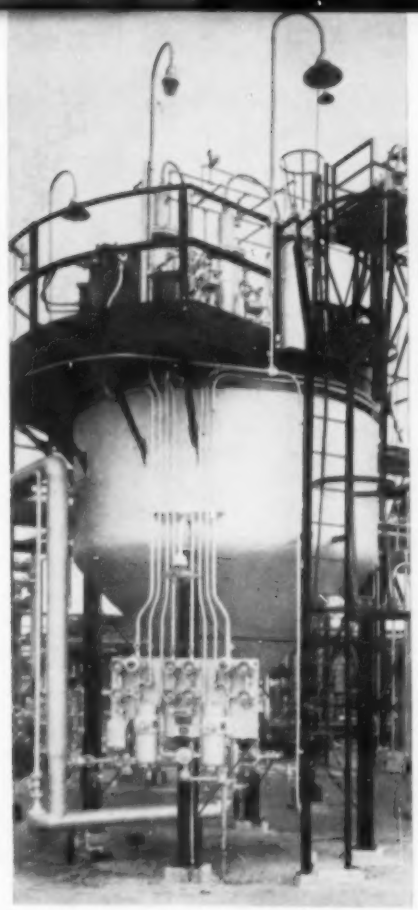
The Pemex tower is an integral part of the plant, both physically and functionally. Its fire resistant construction makes possible its location immediately adjacent to the processing area, eliminating long runs of cooling water piping.

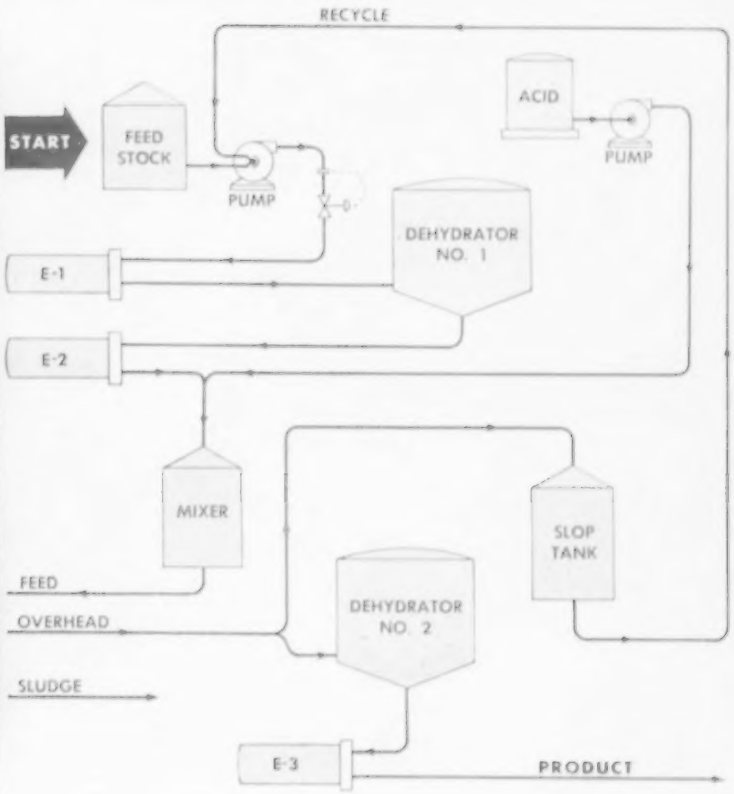
The potential hazard of exchanger leakage is not a worry. In addition to explosion-proof motors for fan drives, Vee-belts are static-conducting, which reduces the risk of an explosive mixture of gas and air being set off by mechanical equipment on the tower.

Corrosion to be expected from cooling tower spray is not a problem. Air passing over the finned-tube coolers gains enough heat in the transfer to become superheated at 132°F and no moisture condenses out over the adjacent plant. The undersaturated state of effluent air plus high discharge velocities also completely eliminates recirculation problems.

Treated make-up water averages about 100 gpm at full load, depending on the amount of continuous blowdown, or overflow. Blowdown is regulated so that solids concentration is kept at about 8-10 times that of the treated make-up water.

Precast concrete construction is a well-established procedure today, but this is probably the first time it has so completely replaced a material as traditionally established as redwood for cooling towers. Previous Hudson installations of this type cooling unit have largely replaced redwood with steel framing and transite or plastic siding, but the Pemex tower is Hudson's largest application of concrete to date.





THIS TREATER HAS IMPROVED lube oil refining for Sinclair

Successful automatic units prove you can . . .

Acid-Treat Lubes Continuously

UP-TO-THE-MINUTE results on two full-scale, commercial plants show that automatic, continuous lube oil acid-treating is a success. The two units, first of their type, have replaced conventional batch agitators, and are providing their operators with nine important advantages.

1—Negligible oil entrainment in the acid sludge.
2—Less viscous, easier-to-pump sludge.
3—Sludge which can be re-used.
4—Reduced acid dosages.
5—Absence of air pollution.
6—No exposure of the oil to the atmosphere.
7—Continuous automatic control.
8—Short acid-oil contact time.
9—Low maintenance costs.

The new installations, at the Richmond refinery of Standard Oil Co. of California and the Houston, Tex., plant of Sinclair Refining Co., are turning lube oil refining, one of the last refinery "arts," into a process as scientific as lighter distillate processing. Continuous operations and control by instruments have replaced operator's guesswork.

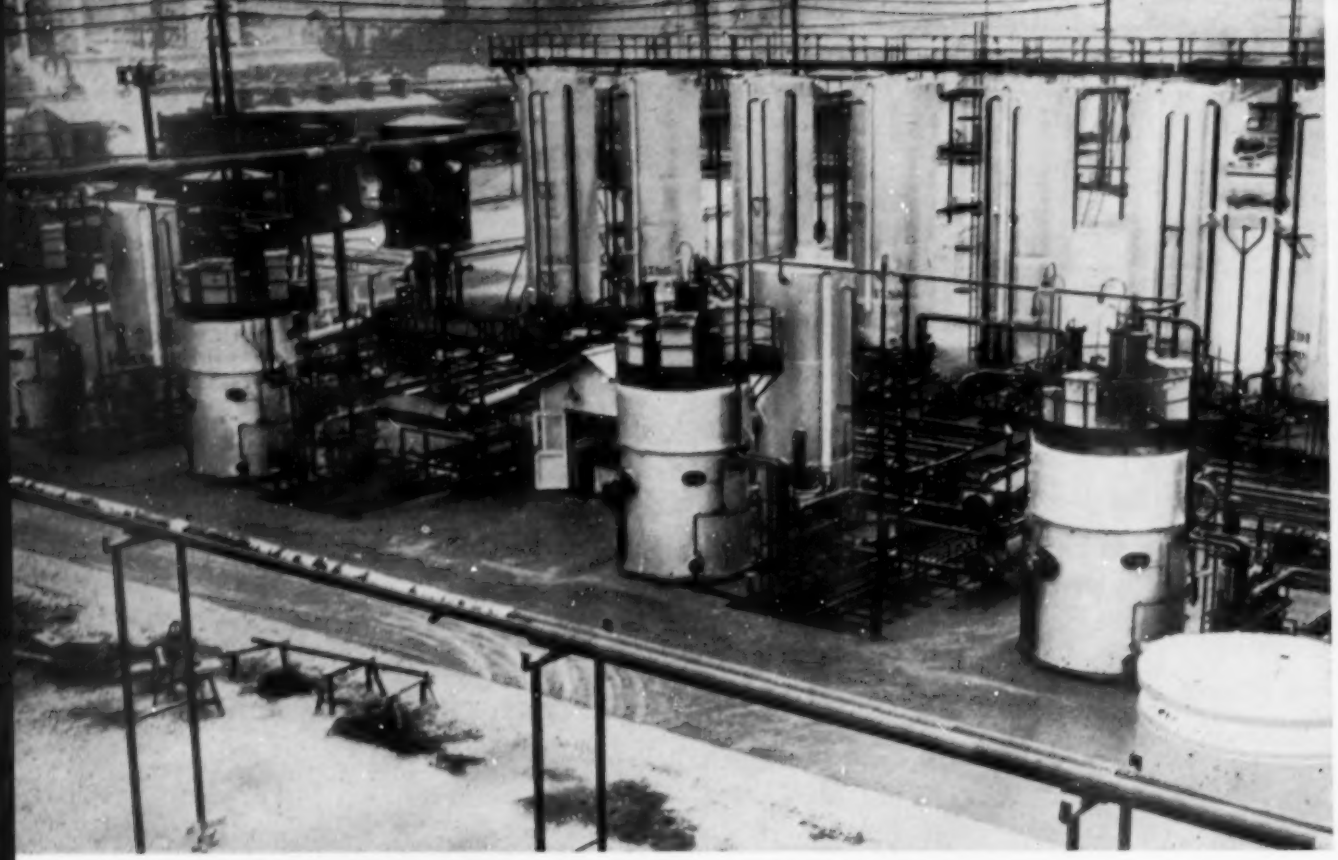
Essential element in both plants is the Petreco "Electrofiner," developed and designed by Petrolite Corp.'s Petreco Division. The illustrations show how the unit at Sinclair fits into the general processing scheme.

The new electric treating system replaced the conventional batch agitator units at both refineries. At Cal Standard, four separate units are arranged so that any of 30 different types of oil charging stocks can be processed through the plant, which has a total design capacity of 12,000 b/d. Two of the units are in lube oil service. The other two handle oils requiring a high degree of refinement: turbine oil, white oil, and transformer oils. Fuming acid is used for three. Then the lube oils can be treated with the acid sludges thus produced. This effects a considerable saving by eliminating the cost of fresh acid.

The viscosities of the various stocks treated range from 40 to 2,000 SSU at 100° F. Operating temperatures also vary considerably, depending on the oil being treated, ranging from 100 to 180° F.

Acid dosages are determined by the nature of the stock and the degree of refinement required. They vary from 12 to 50 lb/bbl or more. Higher values are applicable to the white oils and others where high purity is required.

What the units will do: The unit installed at Sinclair has a capacity of 3,000 b/d of raw lube distillates, which are treated with various proportions of 98% sulfuric acid. In both plants the powerful electric fields in the Petreco units reduce the amount of sludge carried over in the treated oil to very small quantities—



FOUR TREATERS CAN HANDLE 30 different charge stocks at Cal Standard

less than 0.1% for the low viscosity oils and about 1% for the heaviest. Separation of the sludge from the oil is so complete that the amount of the oil entrained in the sludge is usually negligible and seldom more than 1% of the sludge volume.

The raw lube stock is pumped continuously from storage at an automatically controlled, preset rate of flow. Acid is also metered continuously and automatically in the oil stream, the dosage being fixed by a proportioning pump. The mixture is then passed into a mixer where a high degree of dispersion of the acid is produced in the oil. This promotes efficient contact between the two materials, fully utilizing the acid. By heating the oil before mixing it with the acid, the optimum temperature conditions for the reaction can be established. The short contact time minimizes undesirable side reactions. Such intimate mixing and elevated temperatures cannot be used with batch agitation processes because of the resulting degradation of the oil.

At California Standard, the oil-acid mixture is cooled immediately after it leaves the mixer in order to retard additional reaction. It is then fed directly to the electric treating equipment. The Sinclair refinery prefers to cool the stream after electric treatment. Conditions that are specific to the stocks contribute to the designer's choice in this matter.

The overhead oil, freed from sludge by the electric field, is then sent directly to the neutralizing section of the lube oil plant. There, it is treated with alkali and finished in various ways depending upon nature of the oil processed and the degree of purification required. This is still being done in conventional equipment. Current progress in the development of a continuous neutralizing process is such that it should be in commercial operation soon.

Process flow details: Referring to the diagram: charge oil comes in through exchanger E-1, where it is heated by steam to an outlet temperature of 150° F. It then flows under 26 in. Hg vacuum to a Stratco dehydrator. From this unit, it goes through exchanger E-2, where it is cooled, and then joins the acid stream.

Acid is taken from storage by a proportioning pump, with flow under ratio control with the oil stream.

The combined stream goes through a mixing section and into the electric treater, or precipitator, where the two phases are quickly separated in an electrostatic field. The precipitator is operated at about 36 psi. Table 1 shows the temperatures.

Overhead product from the treater flows through a pressure reducing valve to a second Stratco dehydrator, operated at 26 in. vacuum, for removal of sulfur dioxide. From this unit, product is pumped through exchanger E-3 where it is watercooled to about 90°F. and flows to a series of three surge tanks, operated cyclically. From these tanks, the acidulous oil is pumped out to soda ash neutralization, water wash, and then storage.

Acid sludge from the treater flows under level control to sludge blending, where it joins some sludge from Sinclair's alkylation unit, as well as any sludge which may have settled out of the oil in the product line surge tanks.

The electric treater itself consists of a vertical cylindrical vessel with a cone bottom. It is 10 ft in diameter and 16 ft in overall height. Its volumetric capacity is approximately 90 bbl. The transformers are mounted on top of the tank and all electric controls are enclosed in explosion-proof fittings. The high voltage lines are also completely enclosed in conduit to eliminate fire or personnel hazard.

Dual electrode systems mounted inside the tank provide conditions for maximum sludge precipitation. This electrode design is especially desirable

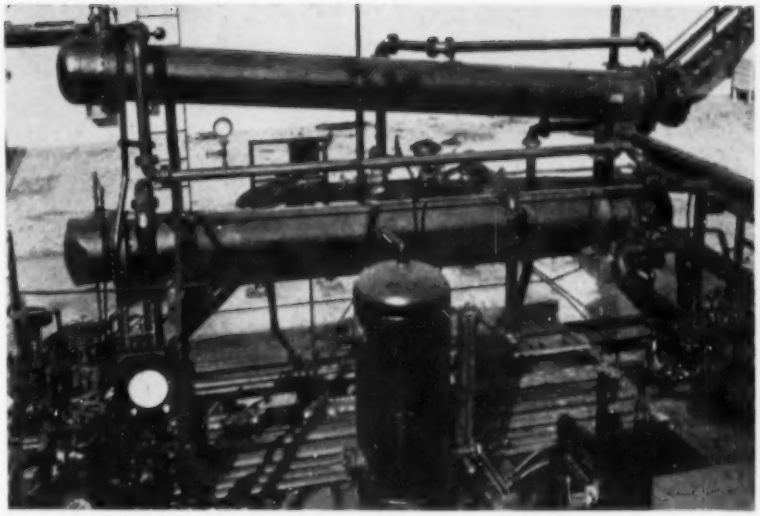
when operating on lube oils in the higher viscosity range. The total electric load for a unit is less than 5 KW, although the power supplies are rated for 15 KVA, Sinclair states.

Why acid dosage is low: Because of the intimate mixing permissible with this effective sludge precipitation system, the necessary acid dosage to produce a given quality product is considerably less than in the conventional agitator. In many of the oil streams treated, it's possible to obtain the desired quality of oil with only little more than half the acid formerly required.

Furthermore, the controlled temperature, short contact time, and the quick separation of the phases produces an oil of superior quality. An additional and important advantage of the reduced acid requirements is the corresponding lower amounts of acid sludge that must be disposed of. This is itself a consideration of no small magnitude.

Because the acid sludge is rapidly separated in the absence of air or water, it does not carbonize or become extremely viscous, and can, therefore, be pumped or removed directly under the treater pressure. The automatic withdrawal of sludge under liquid level control is made practicable by its fluid quality. The automatic feature permits holding the sludge at a level that precludes the loss of oil by entrainment in the sludge. Because the sludge is, in addition, not contaminated by water added as a gathering or "coking agent in the agitator method, it is suitable for use in the treatment of other oils.

At the Standard plant, the acid treating stages are carried out by "interrupted counterflow." The acid from the final stages of treatment of highly refined oils may be used in the initial stages of or in the initial treatment of lube distillates. Thus the maximum economy of acid utilization is achieved.



TO STOP SLUDGE DEPOSITS, Cal Standard mounted exchangers on a slant

Utilities and labor costs are low for the system at Standard. For example, the electric load on each precipitator is only about 3 KW, and in both the Sinclair and Standard installations, one man easily operates the electric acid treating section.

The cost of the complete plant at Cal Standard is approximately $100 per barrel of daily throughput, compared with about $60 for the Sinclair installation. A part of the higher cost of the Standard installation is attributable to piping manifolds for interchangeable operation and to the facilities provided by Standard for their sludge re-use system, which has in turn effected overall acid savings as much as 30%.

The tables illustrate the type of results at Sinclair's refinery. Table 1 shows the various stocks processed, the acid dosages, treating temperatures, flow rates, and amount of residual sludge in the treated oil. Table 2 gives an idea of the difference in yields between the continuous electric process and the former batch agitator operation. When these increased oil yield figures are added to the advantages already cited, the outstanding superiority of the new processing becomes readily apparent.

No exact records of maintenance on the treaters are available, but Standard has found that maintenance costs in the acid-treating section have dropped 11% overall since the new continuous unit went on-stream. The electrical equipment of the plant has had a good service factor; this is particularly true of the high voltage insulation.

To combat possible corrosion, the exchanger tubes are bimetallic: carbon steel on the oil side, and admiralty on the water side (Standard uses salt water for cooling). The coolers at Standard have been mounted in a sloping position, as shown in the photograph above, to eliminate the problem of sludge deposits.

It was to be expected that the trend to continuous processing in the refinery would inevitably be extended to lube acid-treating. This has now been accomplished. Both companies have been found the employe training program could be reduced and that specific schedules of rates, dosages, temperatures, electric conditions, etc., could be set up, with confidence that satisfactory oil products would be reliably produced.

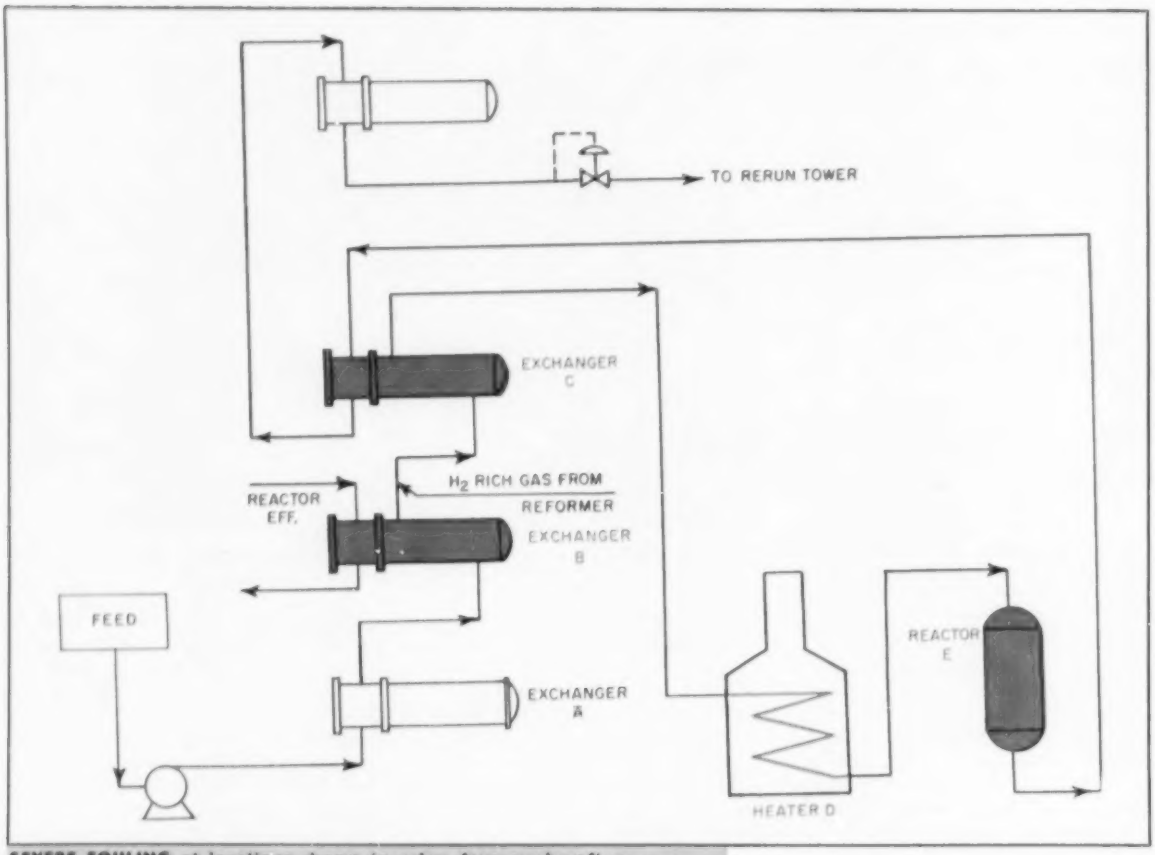
Table 1—Typical Lube Oil Treating Results at Sinclair

(using 98% Sulfuric Acid)

Stock, SSU vis @ 100	Acid dosage lb/bbl	Temp °F	Flow rate bbl/hr	Entrained oil in sludge, %	Average Sludge Carryover, vol-%
55-60	10	100	150	Nil	0.05
100	13	110	140	Nil	0.1
300	20	125	125	Nil	0.2
1200	35	150	100	Nil	0.6
Heavy	35	170	75	Nil	0.8

Table 2—Comparison of Oil Yields from Continuous and Batch Processes

	WHEN TREATING OIL OF Low Viscosity	High Viscosity
With batch agitator	93%	about 80%
With continuous method	95%	about 85%



SEVERE FOULING at locations shown in color, four weeks after startup, led to . . .

The Case of the Fouled

Mystery No. 1—What Is Causing this Fouling?
SOLUTION—Oxidizable Sulfur Compounds in Feedstock

Mystery No. 2—What Is the Accessory Culprit?
SOLUTION—Dissolved Oxygen

Mystery No. 3—What Can Be Done About It?
SOLUTION—Control this Oxygen in Feedstock Storage

These three mysteries were problems faced by Ohio Oil Co. in the feed preparation unit on its new catalytic reformer. Sharp technical sleuthing uncovered the solutions. Here are step-by-step deductions that solved the "foul" crime and produced a new test for determining dissolved oxygen in liquid hydrocarbons.

By JAMES A. BIEHL and WILLIAM T. MADDOCK
The Ohio Oil Co., Robinson, Ill.

ON JULY 27, 1954, an 8300 b/d catalytic reforming unit was placed on stream at the Robinson, Ill., refinery of Ohio Oil Co., as part of a major expansion program for quality improvement.

Charge to the unit consisted of a virgin heavy naphtha of 240-400°F boiling range from an Illinois basin crude.

Almost immediately after startup, severe fouling was encountered in the feed preparation unit, as shown in the diagram above. It occurred in feed preheat exchangers *B* and *C*, the heater *D*, and the catalytic desulfurization hydrogenation reactor

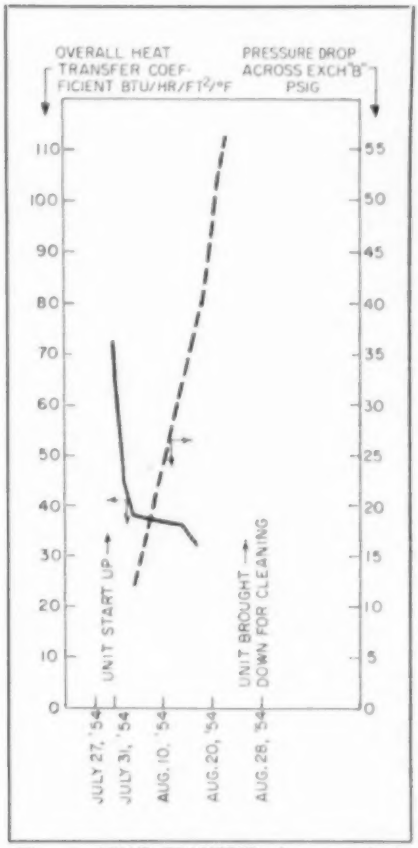


Fig. 1—**HEAT TRANSFER** dropped fast, pressure drop rose once fouling started

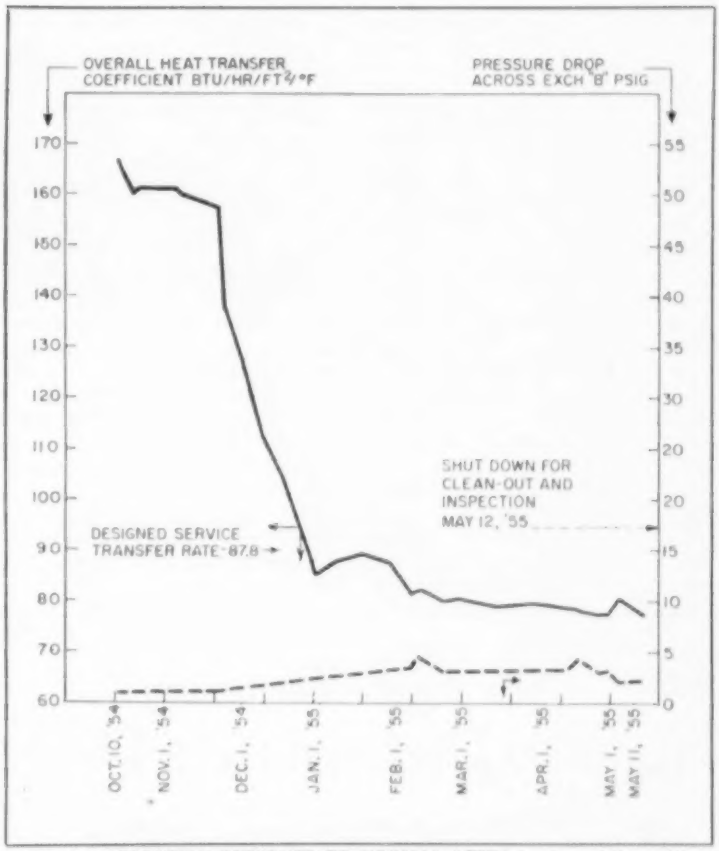


Fig. 2—**OPERATION RETURNED TO NORMAL AFTER** feed naphtha with controlled oxygen content was used

Feed Preparation Unit

E. Conditions at these locations were temperatures in the range of 250 to 700°F and pressure of approximately 425 psig.

On Aug. 28, after four weeks of operation at reduced throughputs, this fouling caused a shutdown for cleaning. The rapid drop in heat transfer and the build-up in pressure drop across the exchanger is traced in the chart, Fig. 1.

Chief suspect as the cause of the fouling was the oxidizable sulfur compounds in the feed. Care, therefore, was taken at shutdown to obtain representative samples from the exchangers and the reactor. Laboratory analysis of the deposit showed the following, confirming our suspicions of oxidizable sulfur as the cause of the fouling:

Total sulfur	14.70%
Free sulfur	2.23%
Chloroform soluble constituents	26.26%
Carbon (combined)	17.92%
Nitrogen	0.24%
Residue on ignition	19.81%
Iron	7.57%

We then tried to remove the oxidizable sulfur compounds from naphtha in storage by scrubbing in a 13% caustic solution. It was hoped that a major portion of the materials were acidic in nature and would be removed. However, fouling continued, indicating that very little oxidizable sulfur was removed.

Minor changes in processing the charge stock also brought no improvement. Pressure drop rose on exchanger *B* from 0.2 to 10.6 psig in 19 days of operation.

The next step showed we were going in the right direction. Suspecting that fouling could be eliminated by controlling the dissolved oxygen content in the charge stock, we rerouted the naphtha flow. We bypassed the cone-roof charge storage tanks, moving the naphtha directly from the crude unit gasoline splitter. Pressure drop across exchanger *B* rose 0.4 psig in four days (from 10.6 to 11.0), indicating that control of the dissolved oxygen content minimized fouling.

The next decision was to gas-blanket both cone-roof storage tanks, using catalytic reformer separator gas (oxygen-free). Without such a gas blanket, normal atmosphere above the naphtha level in the tank had been found to contain 18.5% oxygen.

Before the blanketing was done,

the tanks were emptied of oxygen-contaminated naphtha and purged with an inert gas from a generator in the catalytic reformer section to reduce the oxygen content in the vapor space to 0.5-1.0% oxygen. Tanks were then filled with cat reformer separator gas and pressure was controlled by a supersensitive regulator at ½ oz. The tank was also equipped with a pressure-vacuum vent valve which controlled at ½ oz. pressure or vacuum and permitted the expulsion of gas during periods of temperature increase. A decrease in temperature caused the regulator to allow more separator gas to enter.

This regulator must be sized adequately so as provide for extreme temperature changes, such as those caused by sudden rain following hot sunny weather.

We then returned to operation, with the reformer using naphtha of controlled oxygen content, either directly from the crude unit or from gas-blanketed storage.

A very satisfactory run of seven months was obtained, which was ended for a complete unit inspection. The rate of fouling for this period in exchanger *B* is shown in Fig. 2.

Immediately after this seven-month run started, a laboratory procedure was developed to measure the quantity of dissolved oxygen in the naphtha charge. The test procedure is detailed below.

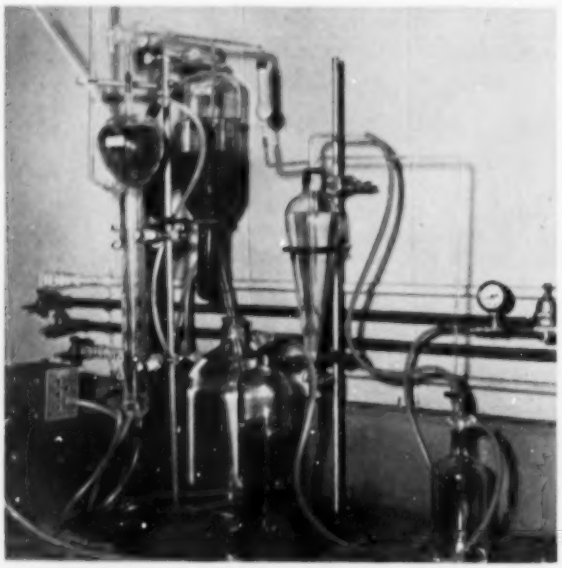
We found the oxygen content of the naphtha as it came from the crude unit to be 5-7 ppm. When this naphtha was allowed to contact air for a period of 24 hrs, the oxygen content went up to 55-60 ppm. Further lab test indicated that dissolved oxygen equilibrium was reached in about 24 hrs of contact with air without agitation.

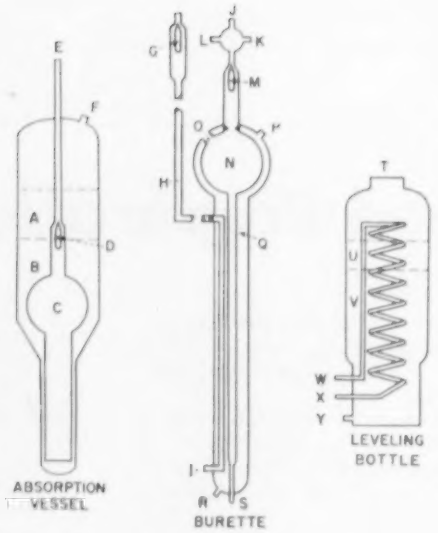
The dissolved oxygen content on naphtha from the crude unit was cut further, to 1-2 ppm by steam stripping in the gasoline splitter. However, this practice was discontinued because of increased corrosion rates in the splitter overhead condensers. We also tried reducing the naphtha end-point and using organic oxygen scavengers. Neither showed any significant reduction in oxygen.

Throughout the seven-month run, frequent determinations of dissolved oxygen were made on reformer charge and charge stock in the storage tanks. The concentration ranged at 2-6 ppm. We also made frequent determinations of the oxygen content of the gas blanket (this was by standard Orsat method), and found it in the range of 0.5-1.0%.

There are, of course, hazards involved in gas-blanketing with hydrogen-rich gas—the only suitable H_2S-free gas stream in the refinery. Therefore, we decided to study the possibility of using double pontoon floating-roof storage to provide protection from oxygen contamination. We found the following refinery gasoline storage (in floating-roof tanks) had relatively low dissolved oxygen contents: 11 lb RVP full cut straight

How to Determine Dissolved Oxygen





DISSOLVED OXYGEN TEST UNIT and the three principal components

THE APPARATUS shown in the illustrations comprises the equipment in Ohio Oil's fast and accurate method for determining dissolved oxygen in liquid hydrocarbons.

The procedure is aimed at elminating errors arising from the presence of hydrogen sulfide, hydrogen cyanide, hydrogen chloride, and carbon dioxide in the liquid hydrocarbon. It uses inert gas stripping and then absorption of the oxygen in alkaline pyrogallate solution.

Chemicals

1—Alkaline pyrogallate solution: prepared by mixing 981 grams of potassium hydroxide with 650 ml of distilled water and adding 15 grams of pyrogallol.

2—Displacing solution: prepared by adding 142 grams of anhydrous sodium sulfate and 30 grams of concentrated sulfuric acid to 956 ml of distilled water.

3—Hydrocarbon seal: a saturated

run, 1.7 ppm; 8 lb RVP catalytic reformate (depropanized), 1.0 ppm; 7 lb RVP Fluid catalytic cracked (debutanized), 2.1 ppm.

With this evidence that floating roofs apparently did a good job of excluding oxygen, we decided to put the reformer charge naphtha into a 55,000-bbl floating-roof tank.

We operated about 4½ months in this way—naphtha from the crude unit to the floating-roof tank to the reformer—and then had to bypass the floater because fouling had started again in exchanger *B*. The apparent oxygen contamination occurring in the floater was verified by lab tests.

We believe this contamination is due to the low vapor pressure of the naphtha at the temperatures met during fall and winter storage conditions —the time at which this run was made. A naphtha of sufficient volatility could probably be stored in a floater satisfactorily. Our material was in the 240-400°F. boiling range with an RVP of 0.77 lb.

In conclusion then, by controlling the oxygen content of the charge stock through use of gas blanketed cone roof tanks we were able to end the fouling in our feed preparation unit that was being caused by oxidizable sulfur and dissolved oxygen. The preferred blanketing gas would be H_2S-free.

Meet the Authors

Mr. Biehl

Mr. Maddock

James A. Biehl, chemist, The Ohio Oil Co., Robinson, Ill., received a B.S. in chemistry from Indiana University in 1943 and joined Ohio Oil shortly thereafter. He served as an Engineering Officer in the U. S. Navy from 1943 to 1946. Jim is a previous contributor to PETROLEUM PROCESSING ("Cut Phenols in Waste by 99.9%," October, 1952, p. 1435,) and a member of the American Petroleum Institute. He makes his home with his family in Robinson.

William T. Maddock also joined Ohio Oil after graduation—B.S. in chemical engineering, Rose Polytechnic Institute, 1947. A registered professional engineer in Illinois, he served as a bomber pilot with the Air Corps from February, 1943, to October, 1945, and completed 18 missions over Germany from England. Maddock, his wife and three sons—7, 3, and 1½ years old—live in Robinson. Bill is a process engineer for Ohio Oil.

petroleum naphtha with a distillation range of approximately 350-500°F. A good quality kerosine is acceptable.

4—Ascarite absorbent: a prepared absorbent of sodium hydrate on asbestos.

5—Nitrogen: compressed nitrogen gas in cylinders is satisfactory if free of oxygen.

Apparatus

The principal components (shown in the drawings) are: an absorption vessel, a measuring burette, and a leveling bottle.

The absorption vessel contains an inner concentric bulb packed with steel turnings, by which absorption is catalyzed. A float valve automatically effects closure when the gas is withdrawn.

The burette is double-walled so that the gas temperature may be held constant by a circulating constant temperature medium. A multiple position stopcock is sealed to the top of the burette for the necessary connections. A float valve provides automatic closure when gas is withdrawn or displaced. The burette is graduated.

The leveling bottle contains a coil for constant temperature control. A three-way stopcock at the opening has one direction to the bottle, one to air, and the third to a source of pressured air (4-6 lb).

The stripping vessel is a standard 1000-ml tapered separatory funnel equipped with a rubber stopper holding a gas disperser, outlet capillary tube (attach an Ascarite absorption tube), and sample inlet tube.

The sample vessel is equipped with a three-way stopcock and a tube extending from the bottom to the end of the sample inlet tube of the stripping vessel. The cock has one direction to nitrogen source, one to gas disperser, and one to the sample vessel.

Equipment is arranged as follows (refer to letter designations on the drawings):

1—Connect points *E* and *J* with capillary tubing.

2—Connect *P* and *X* with plastic tubing.

3—Connect *W* to return side of a constant temperature bath with plastic tubing.

4—Connect *R* to source of constant temperature with plastic tubing.

5—Connect *S* and *I* to *Y* with a glass Tee and plastic tubing.

6—Connect *K* to the Ascarite absorber with capillary tubing.

7—Place a rubber stopper holding a thermometer into opening *O*.

7a—Add alkaline pyrogallate solution through opening *F* until the *B* and *C* zone is full, as noted when float valve *D* seals. Add an inch of hydrocarbon seal to prevent air contact with absorbing solution.

7b—Add displacing solution through opening *T* and seal again with hydrocarbon.

Procedure

Purge the stripping vessel free of oxygen with nitrogen. Purgation can be determined by withdrawing portions of the gas into the burette and making absorptions. When the vessel is oxygen-free, transfer the sample to the vessel by using nitrogen pressure and withdrawing displaced nitrogen into the burette. Size of sample will depend upon oxygen content and burette calibration.

With each full burette of gas, make absorptions and take readings on calibrated portion of burette, making sure the gas is at atmospheric pressure by control of liquid height in tube *H*.

When transfer of sample is complete, start stripping the sample with nitrogen, collecting and absorbing the oxygen-nitrogen mixture until the percent absorption is nil. Withdraw the stripped sample and weigh.

Calculations

Add the amounts of oxygen absorbed from each burette filling. From weight of sample, determine the oxygen concentration in the sample in ppm.

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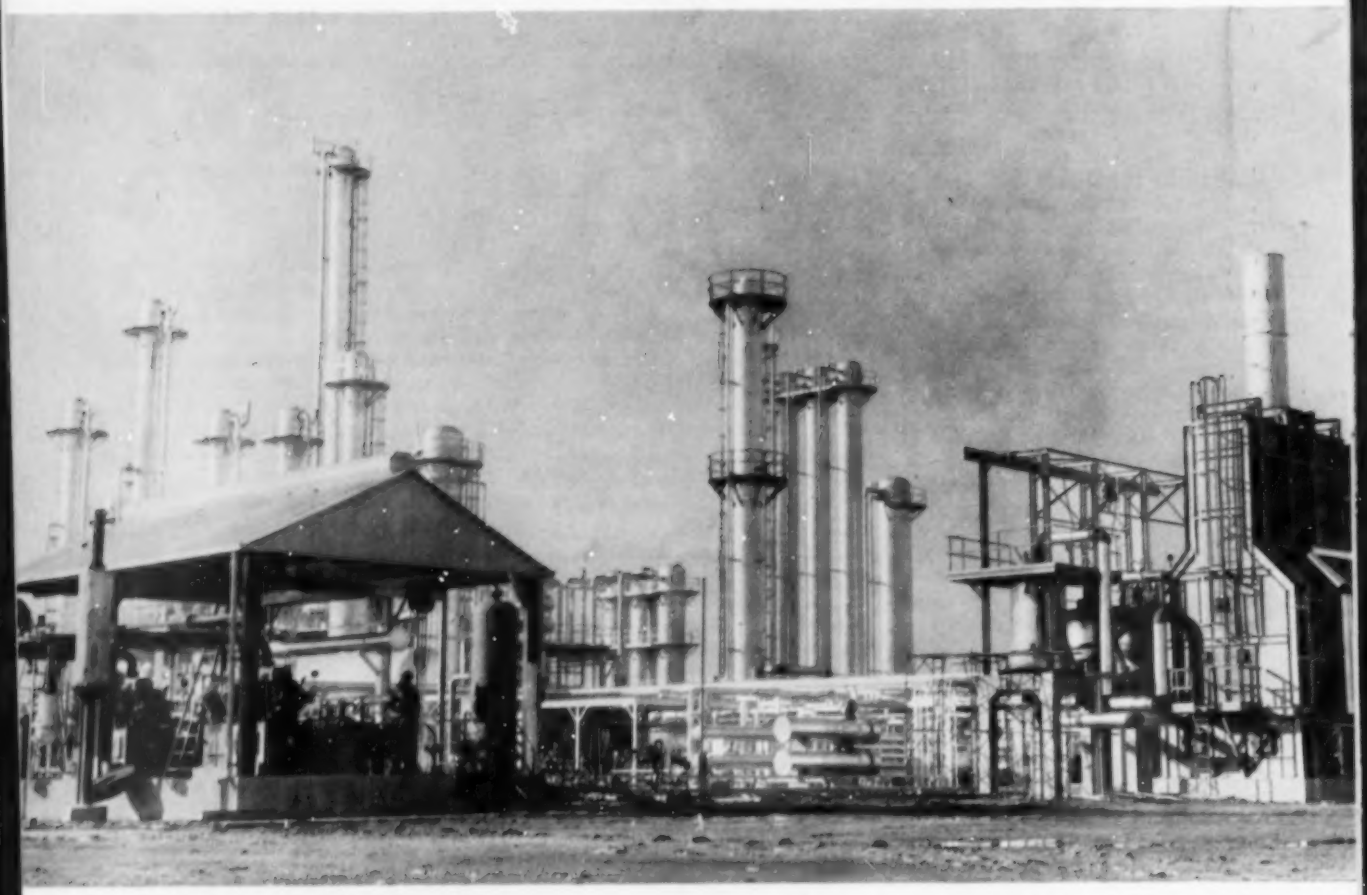


GENERAL VIEW of Southwest's unit: hydrogen recycle compressor at left, gas plant behind it, stabilizers middle foreground, reactors and furnace at right

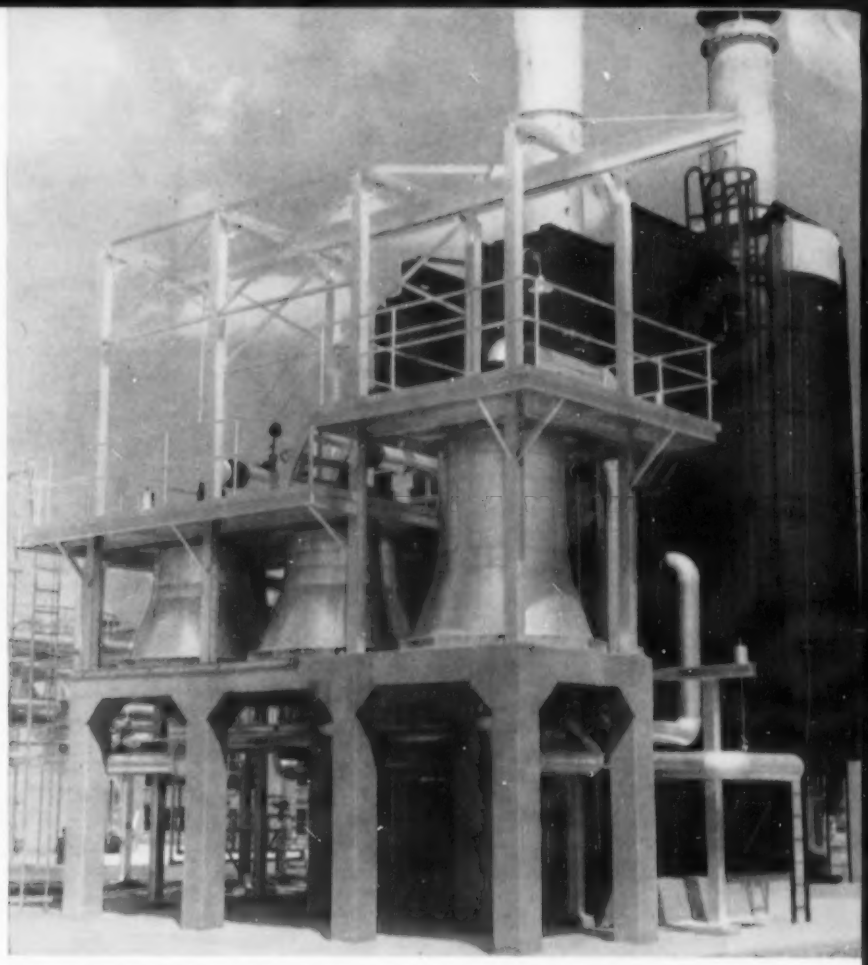
Why Southwest Gas Likes Its . . .

Natural Gasoline Plant Platformer

By R. F. COX and R. H. KILLGORE, Southwest Gas Producing Co., Inc.

An up-to-the-minute report by the operators of one of the nation's first catalytic reforming units in a natural gasoline plant. Southwest Gas has been running this unit over eight months, upgrading motor fuel to octane levels that satisfy their needs in a competitive market. Here's the complete story.

IN NOVEMBER, 1955, Southwest Gas Producing Co., Inc. and Feazel Interests completed construction of a Universal Oil Products Co. Platforming unit at their natural gasoline-condensate plant at Dubach, La. Fish Engineering Co., Houston, Texas, working under license agreement with UOP, engineered and constructed the facilities. The Platformer was of typical design for such units but the concept of application was unique and therefore probably of more than passing interest to operators and techni-



CLOSE-UP OF REACTORS, showing design of supports. Cone sheets are actual support members, not merely skirts

cians who are confronted with upgrading problems.

Since 1948 Southwest-Feazel has operated a natural gasoline plant which processes production from gas condensate reservoirs in the area. The gasoline plant is of the absorption refrigeration and products fractionation design and produces motor fuel as one of its production components. With 3 cc/gal of TEL, the straight run motor fuel has a research octane of 82.5. With the advent of the high compression engine and the resultant requirement for higher octanes, the motor fuel fraction which the plant produced prior to upgrading was confronted with marketing problems due to its octane grade.

The motor fuel fraction from the Southwest-Feazel plant represents approximately 55% of the total liquids production from the gasoline plant and is therefore a major source of revenue from its operation.

To remain in the competitive motor fuel market it was apparent in the latter part of 1954 that some steps would be necessary to improve product quality. A thorough engineering study was conducted to evaluate available processes or methods to improve octane quality which could be operated in conjunction with the gasoline plant operations. Blending upgraded naphthas purchased from outside sources proved impractical due to freight and handling costs. Economic studies showed the need for a process to accomplish the upgrading at the source of motor fuel production, and resulted in the choice of Platforming as the process to be used.

How Plant Operates

The Platformer was one of the first such units to be constructed and operated in conjunction with a gasoline plant processing facility in the nation, and was unique from the standpoint of certain design features which were incorporated for maximum efficiency and flexibility.

The Southwest-Feazel gasoline plant disposes of residue gas from the absorption system through two of the major cross-country transmission lines and does not cycle any of its gas back to a reservoir. Due to this condition the gasoline plant is subject to varying load factors which in turn vary the fluid production from the fractionation section through ranges of 50% to 200% of the daily average annual load.

This feature of highly fluctuating loads is the occasion of uniqueness of design in the Platformer itself. From a technical operation standpoint the desirability of a constant charge rate to a facility such as a Platformer can well be appreciated by the technician since the Platformer is sensitive to feed rate changes from the standpoint of Platformate quality at a given set of operating conditions.

In addition, certain precautionary measures must be incorporated in routine operation to protect the unit from excessive temperature fluctuations within the reactor section and thereby prevent damage to the platinum catalyst. Further, a minimum hydrogen to hydrocarbon ratio must be maintained in order to operate the unit at maximum efficiency and mini-

Table 1—Comparison of Southwest's Platformer Charge and Product with Other Products

	Reactor Charge	Platformate	Natural Gasoline	Premium Fuel	Regular Fuel
I.B.P.	200°F	128°F	98°F	94°F	106°F
5%	221	167	110	120	125
10%	226	191	113	130	128
20%	232	204	116	144	135
30%	239	217	119	160	140
40%	250	228	122	178	150
50%	260	238	126	197	162
60%	274	250	131	214	178
70%	290	267	138	235	198
80%	310	288	148	260	228
90%	335	316	160	296	272
95%	350	342	175	322	307
E.P.	392	388	212	385	355
Rec.	99.5	98.0	98.0	98.0	98.0
Res.	0.5	1.0	1.0	1.0	1.0
Loss	0.0	1.0	1.0	1.0	1.0
A.P.I. Grav.	55.7	54.4	81.8	60.8	69.8
R.V.P.	0.5	2.8	11.0	8.8	8.8
Octane number:					
Clear	47.1	89.4	67.1	—	—
+3 cc TEL	72.1	98.4	87.9	95.3	—
+1.68 cc TEL	—	—	—	—	88.0

mize the possibility of carbon deposits on the catalyst beds.

From these requirements it can readily be seen that a fluctuating load through a gasoline plant processing facility is not conducive to Platformer operation without provision for the elimination of the varying factor.

The problem was eliminated at the Southwest-Feazel Plant by the installation of a 5,000-bbl. storage tank which received the excess 200-400°F naphtha charge stock from the gasoline plant fractionating section. In the gasoline plant fractionating section the prefractionator prepares the 200-400°F naphtha feed stock used by the Platforming unit. After cooling to 130°F., the naphtha feed stock is transferred to the Platformer feed surge tank which has a total capacity of 55 bbl. The small capacity of this tank does not allow for surges in production from the prefractionator and therefore would create highly fluctuating feed rates to the Platformer.

A system of level control equipment and instruments is used on this tank so that any production from the prefractionator which is in excess of the current charge rate to the Platformer flows into the 5,000-barrel naphtha storage tank. A line from the naphtha storage tank returns to the Platformer feed surge tank, and flow is controlled in such a way that Platformer feed is supplemented when production of 200-400° naphtha from the prefractionator is less than the current charge rate to the Platformer. (See Fig. 1 for flow diagram.)

Naphtha temperature in the storage tank is 85°F while that of naphtha from the prefractionator is 130°F. In supplementing the feed available from the prefractionator with naphtha from the storage tank, rather than taking all Platformer feed from the storage tank, a considerable amount of the heat content is utilized, thus reducing the overall heating cost. The incremental savings is admittedly small, but becomes a significant figure over extensive periods of operation. The storage tank is of atmospheric design, but equipped with vapor seal and gas blanketing to assure an oxygen free feed product.

The feed preparation and flow system has given the flexibility needed in the operation of the Platformer and has made it possible to set the Platformer on a specified charge rate and maintain that rate for periods of as much as a week's duration before making any adjustment in charge rate.

In actual operation the feed rate is periodically adjusted so that the 5,000-bbl storage tank is maintained at about one-half its capacity with charge stock. In this way one-half of the tank volume is used for surge capacity and one-half used to supplement low rates from the prefractionator.

Since going on the line, Southwest engineers and operating personnel have been assembling operating data related to the Platformer, and it is felt that sufficient information is available to thoroughly evaluate an operation of this type, especially in view of its application to other gasoline plants which might be confronted with similar problems.

Table 2—Processing Temperature Conditions

	Temp. °F
No. 1 reactor inlet	924
No. 1 reactor outlet	856
No. 1 delta T	68
No. 2 reactor inlet	914
No. 2 reactor outlet	897
No. 2 delta T	17
No. 3 reactor inlet	914
No. 3 reactor outlet	905
No. 3 delta T	9
Total reactor delta T	94

Table 3—Product Distribution

Plant Streams	b/d	MSCF/D	°API or Sp. Grav.	lb/Day	Wt-%	LV-%
Reactor charge	1506	—	55.1	399315	100.0	100.0
Net separator gas	—	824	0.212	13392	3.4	—
Stabilizer gas	—	255	1.20	23352	5.8	—
Platformate	1362*	—	54.3	362571*	90.8	90.5
				399315	100.0	90.5

*By difference, based on 100 wt-% recovery

Corrections to observed data based on calculated specific gravities from M.S. analyses of separator and stabilizer gas made as follows:

	Separator Gas			Stabilizer Gas		
	*Mol-%	MW	lb/hr	*Mol-%	MW	lb/hr
H^2	86.65	1.75	159	12.29	0.25	7
C^1	4.72	0.76	68	4.93	0.79	22
C^2	3.42	1.03	93	21.55	6.48	181
C^3	3.21	1.42	129	59.41	26.20	733
iC^4	0.90	0.52	47	1.82	1.06	30
nC^4	0.80	0.46	42	—	—	—
C^5+	0.30	0.22	20	—	—	—
	100.00	6.16	558	100.00	34.78	973

*Corrected for CO content

Specific gravity from analyses: Separator gas, 0.212; Stabilizer gas, 1.20.

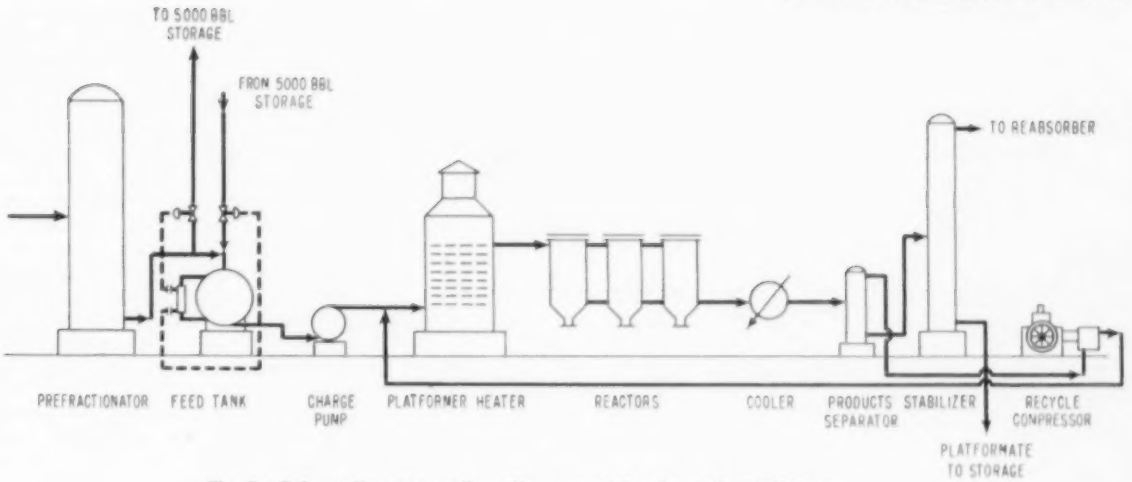


Fig. 1—Schematic process flow diagram of Southwest's Platformer

Operating Results

The operation at the Dubach Plant uses the Platformate as a blending agent with a stabilized natural gasoline to turn out 95 and 88 octane motor fuel. Table 1 shows the characteristics of the reactor charge, the Platformate, natural gasoline, premium and regular grade motor fuels. Examination of the various characteristics set forth in the table gives an indication of the octane appreciation through the Platformer and the resultant effects of the blending with natural gasoline. It will be noted that the 95 octane motor fuel has a higher average boiling range than the 88, which is occasioned by the necessity of using a higher concentration of Platformate for 95 octane production than is required for 88 octane grade motor fuel.

Since putting the Platformer on stream, several performance tests have been conducted for the purpose of securing confirming data as to its efficiency and flexibility.

Table 2 shows the average temperature conditions prevailing during a typical performance test. Table 3 shows production distribution and characteristics of the gas streams from the unit. Table 4 shows the component distribution of Platformate. The ring balance indicates the degree of aromatics production and of naphthene conversion. When considered on the basis of charge stock, the comparison of hydrocarbon ring types gives an excellent picture of how the upgrading is accomplished as well as a measure of severity of conversion.

From the summary of products in Table 4, it will be noted that the Platformate is made up of propane and heavier components with the C_5+ fraction made up of PONA composition as indicated under the ring balance.

Yields from the Platformer are influenced by the amount of lighter components retained in the Platformate. It is desirable, therefore, to main-

Table 4—Summary of Products

Component	Platformate Vol-%	Platformate b/d	Platformate lb/hr	Total Off-Gas b/d	Total Off-Gas lb/hr	Total Production Liq b/d	Total Production lb/hr	Total Production Wt-%	Vol-% (SCF/B) Charge
H_2	—	—	—	—	166	—	166	1.0	(505)
C_1	—	—	—	—	90	—	90	0.5	(33)
C_2	—	—	—	—	274	—	274	1.6	(55)
C_3	0.1	1.3	10	—	862	—	872	5.3	(119)
iC_4	3.5	47.7	393	9.2	77	56.9	470	2.8	3.8
nC_4	5.0	68.1	580	4.9	42	73.0	622	3.8	4.8
iC_5	5.0	68.1	620	1.4	13	69.5	633	3.8	4.6
nC_5	3.6	49.0	450	0.8	7	49.8	457	2.7	3.3
C_5+	82.8	1127.8	13042	—	—	1127.8	13042	78.5	74.9
	100.0	1362.	15095	16.3	1531	1377.0	16626	100.0	91.4
Reactor charge	—	—	—	—	—	1506.0	—	—	—
Separator gas	—	—	—	—	—	—	—	—	(547)
Stabilizer gas	—	—	—	—	—	—	—	—	(169)

Ring Balance	Charge	C_5 + Platformate	C_5 + Platformate Based on Charge
P Vol-%	54	44	33.0
O Vol-%	Trace	Trace	—
N Vol-%	26	5	3.7
A Vol-%	20	51	38.3

Net aromatics = 38.3 − 20.0 = 18.3 vol-%
Naphthene conversion = 26.0 − 3.7 = 22.3 = 85.8%

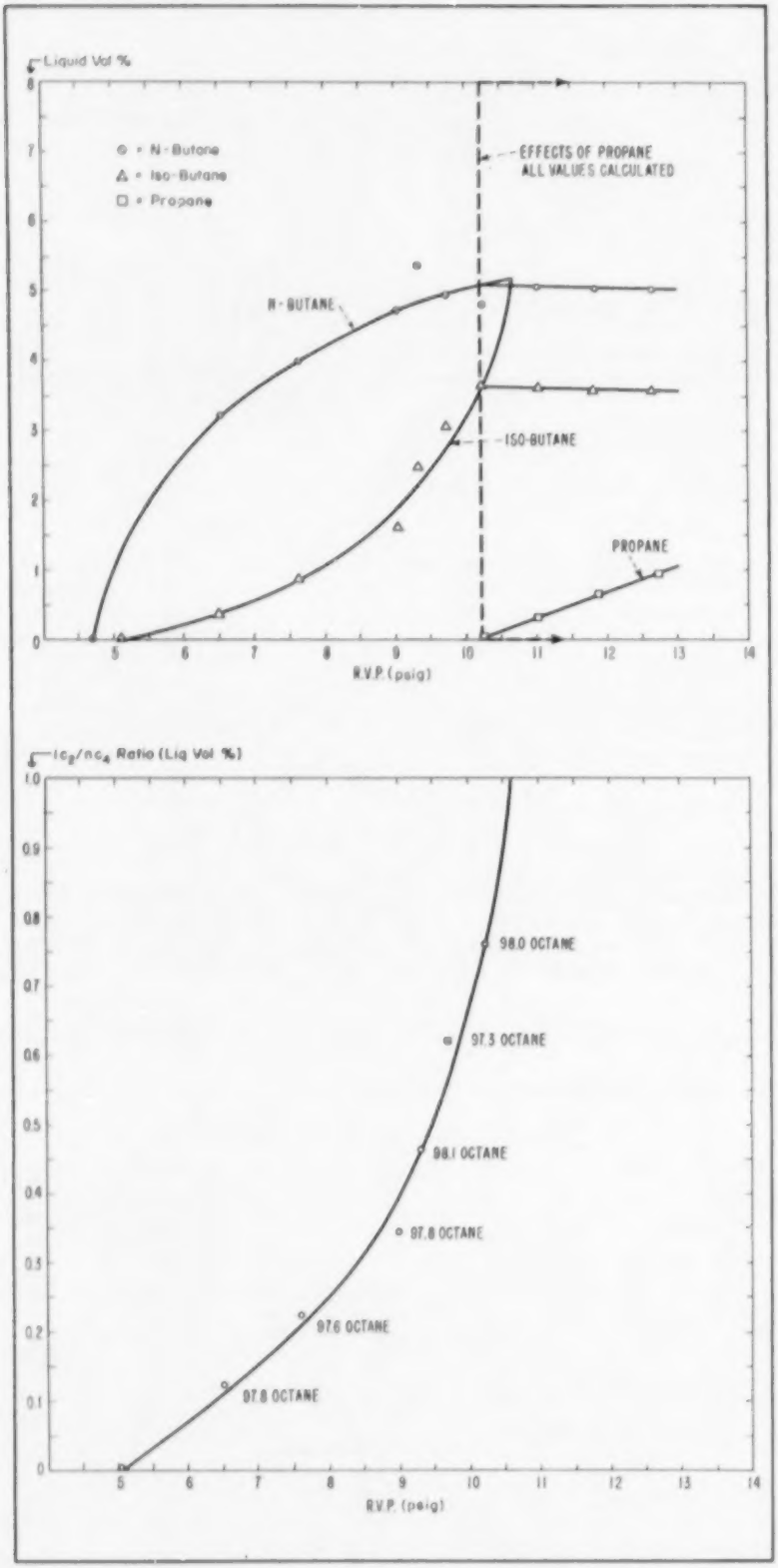


Fig. 2—Relation of light components in Platformate to vapor pressure and octane

tain as high a retention percentage of propane, iso-butane, and normal butane as is practical and yet remain within vapor pressure specifications on the finished product.

Actual operating experience has indicated a desirability of sacrificing yield to the extent of removing all propane and iso-butane from the Platformate by topping with the stabilizer, and to supplement these components with normal butane from the natural gasoline stream. Although propane and iso-butane are high contributors to the total octane, their component vapor pressures limit the amounts which it is practical to leave in the Platformate. Operating experience has shown that removal of these components with subsequent replacement with normal butane actually allows a higher octane at a given vapor pressure standard than is possible by leaving them in the Platformate.

Fig. 2 graphically depicts the relationship between these lighter components and the vapor pressure and octane of the Platformate. Fig. 2 is based upon actual analytical data developed under operating conditions and has been found to give results of sufficient accuracy to predict results when changing operating conditions.

The undesirable light components removed from the top of the Platformer stabilizer are routed back to the gasoline plant absorption-fractionation system for recovery and separation into individual components. This system lends itself very well to the production of any desired vapor pressure Platformate without sacrificing yield. Loss consists predominately of hydrogen which is used as a fuel in the Platformer heater. The platforming process generates hydrogen in excess of its own heat requirements and the excess is diverted to the gasoline plant fuel system.

Supervision

For purposes of close operating supervision, a number of conditions pertinent to the operation of the Platformer are checked at frequent intervals and the data recorded on an operations log. From the log, the data are plotted on a strip chart of convenient size for reference and observation of any drastic change in Platformer performance. Fig. 3 is a reproduction of the type of data accumulated and represents the operation for a period of one month.

There is a purpose in plotting this information as presented in Fig. 3 other than that of recording operating

data. The process engineer can readily observe change in operating conditions over periods of time and predict loss in catalyst activity and replacement of same. Further, adverse processing conditions which might be harmful to the catalyst or to other parts of the unit can be spotted in sufficient time to allow remedial action.

The Platforming Unit was designed upon the basis of 2,000-b/d charge rate for the production of 95 octane with 3 cc's of tetraethyl lead Platformate, or at 1,500 b/d of 98 octane with 3 cc's of tetraethyl lead.

After eight months of operation the unit has proven itself capable of fulfilling all design conditions. At the end of eight months the catalyst had handled a cumulative feed stock in excess of 60 bbl/lb and operating conditions indicated very little loss of activity.

In blending operations of this type the quantities of different octane fuels are governed by the marketing conditions prevailing at any given time. In practice it has been found that it is possible to turn out a motor fuel fraction capable of being blended into the two required grades on the ratio of 40% of 95+ octane and 60% of 88 octane for a pool octane of 91.0+ with a weighted average lead content of 2.25 cc/gal.

Summary

All data indicates the feasibility of Platforming in conjunction with natural gasoline - condensate recovery plants and affords a way for the producer to remain in the competitive motor fuel market with a practical capital outlay. Today the trend is toward even higher octane fuels to satisfy the ever increasing horsepower being built in by automotive manufacturers. Based upon the current trends, octane requirements of fuels of the future will exceed the levels which a Platforming installation of this type, using similar charge stocks, is capable of producing. This condition need not cast the shadow of doom for the natural gasoline-condensate plant operator. Techniques have already been developed which readily supplement the Platforming process and produce the anticipated high quality fuels of the future. With present day technological advances geared to future needs, there is little doubt that improved processes will be available, some of which will be as readily adaptable to gasoline processing plants as was the Platformer to the Southwest-Feazel plant.

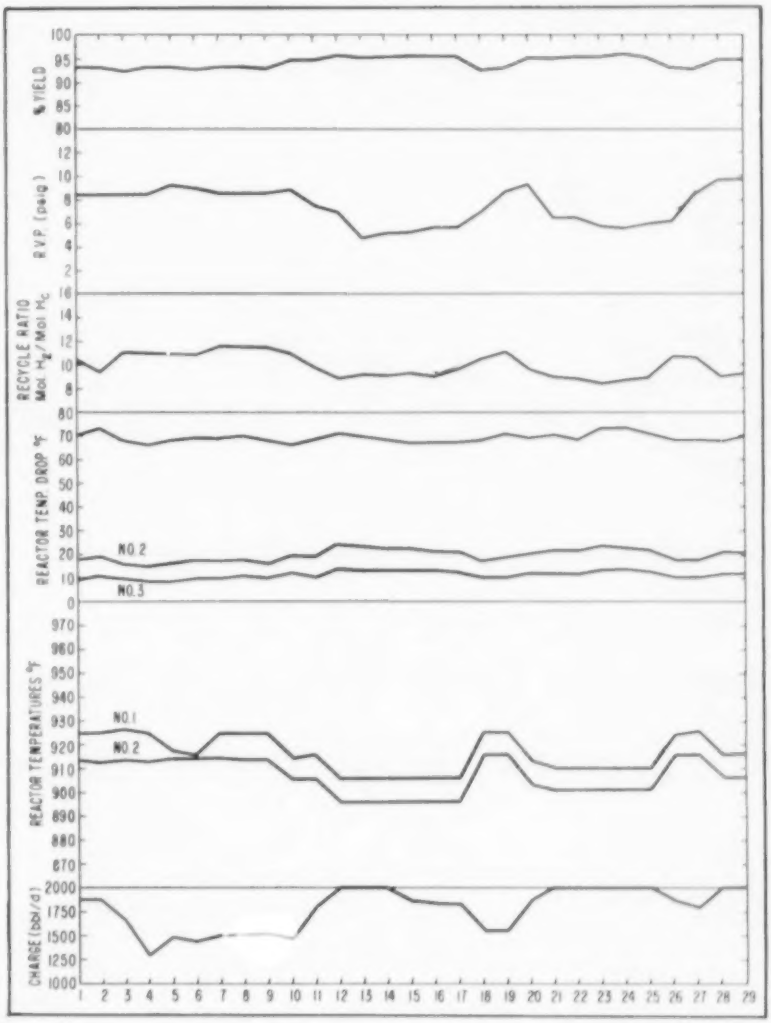


Fig. 3—Log of Platformer operations, one month

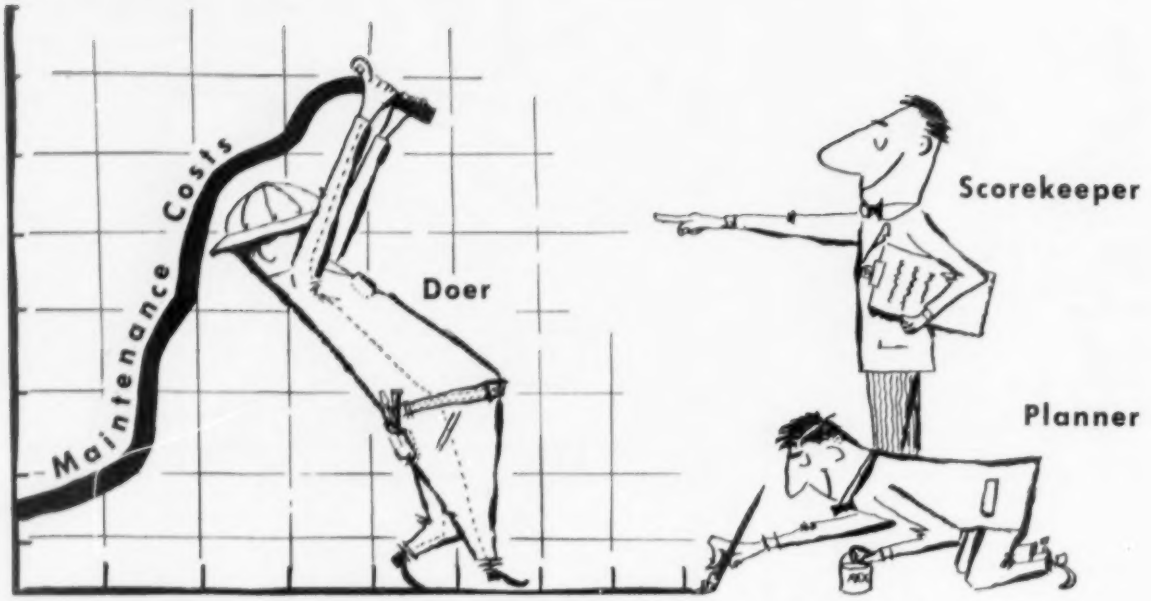
Meet the Authors

Mr. Cox

R. F. Cox is general production superintendent in charge of drilling and production, Southwest Gas Producing Co., Inc., at Monroe, La. He joined the organization in 1948 as a field engineer and later served as process engineer, district engineer and chief engineer. Mr. Cox received his education in the public schools of Louisiana, Louisiana State University, and the University of Oklahoma School of Chemical Engineering.

Mr. Killgore

R. H. Killgore has been with Southwest since graduation from Louisiana Polytechnic Institute School of Chemical Engineering in 1951. He started as a laboratory chemist and later held the post of process engineer. Today he is at the Dubach, La., plant as district engineer.



This Month's M&C Feature

How Sinclair Lowers Maintenance Costs With . . .

Doers, Planners, Scorekeepers

By E. B. ASMUS
Central Maintenance Engineer
Sinclair Refining Co.
E. Chicago, Ind.

REFINERY MAINTENANCE costs are increasing. If we want to stop this rate of growth in maintenance costs, reduce maintenance manpower, and stabilize the portion of the processing dollar used in maintenance, we must continually study, analyze and change our maintenance procedures to fit the times.

We have to provide efficient means to do the job, and see that these means are used. Unplanned work should be at a minimum and scheduling complete and realistic. We must keep score of our work to find those hidden high-cost areas in maintenance.

Sinclair is aware of these problems, and we are concerned about the over-all effectiveness of our maintenance effort because:

1—Over-all maintenance costs are up in line with wage and construction costs.

2—The maintenance portion of total manpower is continuing to increase.

3—The maintenance portion of total manufacturing costs is continuing to increase.

Total maintenance costs have increased in about the same proportion as wage rates and the cost of construction. This points out that little has been lost or gained in over-all effectiveness. In spite of general opinion that present-day manpower is less efficient than 15 years ago, we have been able to keep this effectiveness stable through increased use of mechanical tooling and other improvements.

Total maintenance forces have become an increasingly high percentage of total refining manpower. But this has not necessarily been caused by a loss in maintenance effectiveness. The cause is a combination of the following factors: (1) processing units have become larger, requiring less non-maintenance personnel per unit of running capacity but still requiring about the same maintenance manpower, (2) more process integration, (3) more effective instrumentation, (4) more high-maintenance-cost units of the petrochemical type, (5) revisions in accounting procedure, (6) greater use of clerical machinery, (7) etc.

As one proceeds with improving operational efficiency through these media, maintenance becomes more critical and becomes a larger and more important factor in overall control.

Maintenance is costing an increasingly large portion of each manufacturing dollar spent. This further emphasizes that maintenance has not improved in line with other factors of manufacturing cost. Maintenance has not been able to hold the line cost-wise.

These are not perfect yardsticks for measuring maintenance effectiveness but do illustrate that maintenance costs are higher and warrant concerted effort to improve and bring them in line.

A high "onstream" factor is a joint responsibility of operating and maintenance groups. Maintenance, as a service organization, has the responsibility of seeing that all necessary maintenance, repairs and alterations are completed as quickly and as effectively as possible in order to meet production schedules.

Needless to say, operations can make an impossible task of this by improper scheduling of production, abuse of equipment, errors in judgment, etc. Such abuses can cause excessive overtime, excessively high maintenance employment and prolonged "off-stream" times.

Operations and maintenance must act as a joint manuafcturing team or partnership with a common goal of maximum economic return. It is evi-

dent that maintenance effectiveness is one of the more important factors in overall plant economics and must be fully considered in any overall planning or scheduling. Possibilities for economic improvement hinge more and more on the effective use of maintenance.

Maintenance groups, in order to function effectively, need to be proficient in the following three main functions:

1—Maintenance needs effective "planners."

2—Maintenance needs effective "doers."

3—Maintenance needs effective "scorekeepers."

If maintenance can improve in balance and effectiveness in these three areas, economic improvement is bound to result. Each of these functions has to become an important, well defined function of each member of the organization from the janitor to the head of the management group. The status of each will determine the extent to which "doing, planning or scorekeeping" is involved, but complete delegation of any of the above functions is impossible except in a few specialized cases such as specific clerical help.

In improving maintenance effort, our prime object is to increase the effectiveness of this "doing." During the past several years a considerable amount of magazine space has been devoted to productive maintenance, maintenance accounting, maintenance yardsticks, etc. All of these things are good and denote a recognition that maintenance can improve through use of these planning and scorekeeping tools. However, all of this is contingent upon the actual "doing" or efficient use of these tools in getting the work done.

It is my belief that we should be careful not to place too much emphasis on the use of these tools and forget the actual "doing" of the job. We must not forget that to get the job done is the most important part of our maintenance work. If we do not get the job itself completed properly and efficiently, all production and plant economics suffer. We then should first . . .

Improve Our "Doing"

As a simple example, let's consider how we have improved the "doing" of janitor work. This has been done by providing good modern tools, floor waxers, floor scrubbers, special motorized scaffolds for window cleaning, etc., and by training our janitors to use this equipment.

The janitor himself is the primary doer, but he has become a planner and scorekeeper to some extent in deciding how, when and why he uses the tools provided. Contrary to this, his immediate superior is primarily a planner and a scorekeeper and only incidentally a doer. The supervisor plans in what order this work can be done most efficiently and keeps track of the time and cost in order to keep score of how the work is progressing.

Many similar examples of improving the "doing" of work take place every day in our still cleaning, our exchanger cleaning, our pipe work and in all of our maintenance work.

We must continually provide the best in tools and equipment for our workmen so that they can do their work with minimum effort and in minimum time. We must plan for better tools and equipment, we must train supervisors and craftsmen in their use, and keep score to see whether we are obtaining the desired economic results.

Tools should be kept in good condition and be kept up to date. The labor and time saving ability of power tools should be constantly analyzed. Proper and sufficient yard equipment can tremendously reduce manpower requirements and downtime.

Adequate transportation facilities can make big savings in manpower, time and materials. Transportation is cheap compared to present-day labor costs, providing the labor saved is put to constructive use.

Portable shops in trailers or self-propelled units can save much time and material by bringing the minor shop tools to the job. In larger installations these portable trailer shops are kept busy almost constantly.

In new construction design, operating units should be spread out or arranged to accommodate present-day use of power tools, yard equipment, etc., to reduce turnaround time appreciably. Overhead interferences should be located advantageously for use of equipment. New operating units should be economically designed with many maintenance facilities built-in, i.e., handling beams, trolleys, davits, lugs for tying in rigging, etc. All such facilities can be installed more economically during the original construction because at that time line and other interferences can be eliminated while the unit is still on paper.

Vessel exterior manways should be sufficient in number and size for serviceable use, and should be installed on all vessels. Internal manways should be eliminated in dirty service equipment.

Platforms should be adequately sized. A thousand-and-one other things can be and are economically built into new units to save maintenance manhours, downtime and materials.

Roads and aisleways should be surfaced to allow use of labor-saving yard equipment. They should be made wide enough to allow traffic to flow in both directions, thus reducing expensive detours and waiting periods, and they should have adequate overhead clearance to allow movement of yard equipment with minimum interference.

Shops should be centrally located and grouped for maximum supervision coordination, for minimum inter-shop handling expense, and arranged for efficient work handling, with adequate tools, equipment, etc.

If we are to improve the actual "doing" of the job, we must continue to constantly study these possibilities by means of plant task force commit-

How Sinclair Circulates Maintenance "Know-How" Among Its Refineries

PROOF of Sinclair's desire to keep all of its refineries up-to-date on problems and solutions common within the company is its Biennial Maintenance and Engineering Symposium.

The program, started in 1952, is designed to discuss and solve past and present mechanical problems met in the company's refineries. The goal: increased return on maintenance money spent. The first Symposium was held at East Chicago, Ind., the second at Phildelphia, Pa., in 1954, and most recent, in 1956, was held in Wyoming.

Usually four days long, the Symposiums help develop an open-minded approach to new maintenance methods, and foster active thinking on problems of mechanical tools, management tools, and analysis tools needed for maintenance.

Attendance at the Symposiums is made up of teams from each of the seven Sinclair refineries, plus other companies and departments when it seems desirable. The teams represent engineering, maintenance, inspection, operations and management personnel, as well as research, the central mechanical and engineering coordinating group, and top refinery management.

Introducing a New M&C Panel Member—Edward F. Mann

Mr. Mann

Mr. Edward F. Mann, supervising industrial engineer for The Atlantic Refining Co., Philadelphia, Pa., has replaced Mr. F. O. Pierson (formerly chief manufacturing Industrial engineer for Atlantic) as a member of PETROLEUM PROCESSING's Maintenance and Construction Panel. We shall miss Mr. Pierson's contributions, but wish him the best of luck in his new position as executive vice-president of Q-Tips Corp. at Long Island City, N.Y. We feel, however, that Mr. Pierson has turned his Panel activities over to a very competent successor.

Ed Mann was born in Philadelphia in 1913, and attended school there. He studied Business Adminstration at Wharton Evening School, University of Pennsylvania from 1932-1938, metallurgy at Temple University from 1940-1941, and mechanical engineering at Rutgers University Evening School, 1941-1943.

In 1945, after working in time study and industrial engineering he joined the Atlantic Refining Co. at Philadelphia where he became shops section supervisor directing industrial engineering work in a number of shops. He next became temporary assistant chief (then permanent assistant chief) industrial engineer, during which time he directed revision of all Field Standards developed and sold standardization and training programs (including Standard Practice Instruction Manuals) for field craftsmen and trainees, machine operators, administrative controls, job standards and revised performance standards. His present title resulted from a reorganization of the Industrial Engineering Div. in 1953, when the title of assistant chief was changed to supervising industrial engineer.

Ed, who is married and the proud father of six children has been active for many years in the Philadelphia Chapter of the Society for Advancement of Management for which he has been a member of the Board of Directors and Chairman of numerous committees.

He frequently speaks at Maintenance and Management Conferences, and has lectured at the Drexel Institute Graduate School, Rutgers University Evening School and Temple University Industrial Seminars. His hobbies are American history, collecting Americana, hunting, fishing, riding, and gardening.

---

tees, by central intra-plant coordination and by company inter-plant meetings to discuss and solve maintenance problems.

An exchange of maintenance methods and ideas between companies with similar problems has proven highly advantageous to everyone involved.

There is no substitute for "good supervision" in maintenance, however, the term "good supervision" is much overworked. Often, good supervision is what we have when we are pleased with the results of what we are doing and what we don't have when we are displeased.

If we are to improve the "doing" of our work, we must not only make the job easy for the craftsmen and make it possible for the craftsmen to do the job in the least amount of time, but we must provide that all-important element "good supervision." One method of improving supervision is to . . .

Improve Our Planning

There are many ways of improving our work preplanning, and our manpower scheduling, which is the end result of planning. Many articles have been written on the subject and several consulting companies are making a good livelihood out of teaching novel ways to do this job. All methods have their good and bad sides. However, we have preferred "pulling ourselves up by our bootstraps." In other words, we feel that if a planning system is to become effective for us it must be developed by us.

The mortality rate of new maintenance systems and procedures can be particularly high unless all levels of management are thoroughly convinced that improvement can be had, and constantly work to make the revised procedure do what it was designed to do.

Time spent in laying adequate groundwork, preferably by those who will administer the system, is a cheap way to insure success. Too often planning and scheduling systems only work while the party advocating the improvement is deeply involved. As soon as this party leaves the scene the system will develop either real or imaginary bugs and the system is then deemed no good because of a lack of primary selling because of laziness on the part of those responsible for making the system click, because of a shortage of clerical help during the period of change and/or because of the natural resistance to change. We therefore, subscribe wholly to the theory that the first point is most important, i.e., develop the "want" to improve, remove all possible roadblocks to improvement, and encourage and insist on maintenance doing the job itself.

If we are to improve we must—first of all—find out what the craftsmen need besides facilities in order to do a better job. At least 90% of our people want to do an efficient job and, in fact, get a great deal of pleasure and pride from doing a good job.

Once we accept this fact and apply positive thinking to the fact that we can improve, we must determine what roadblocks supervision and management are apparently placing in the way. If these can be reduced, the "doing" automatically improves.

Once good working facilities are provided craftsmen indicate that the following list of roadblocks are still evident:

1—"The equipment wasn't shut down and we had to wait."

2—"We no sooner got there than we had to move to another job."

3—"The foreman assigned too many or not enough men."

4—"Everything is an emergency job."

5—"We are waiting for reassignment."

6—"The material wasn't delivered when we needed it, or wasn't ordered."

7—"We had to wait for other crafts to complete their work first."

8—"We needed supporting crafts and they weren't available."

The list can be extended indefiinitely. Formerly I thought that these were only excuses, but if you take and check these standard replies you will find, as I did, that there is a lot of truth in them. In other words, we have placed roadblocks in workmen's way by not planning and scheduling work.

The line foreman is one of the most important men in a maintenance organization and, if he isn't getting the job done there are probably roadblocks in his way also. He "gets it"

Who Is on Your M&C Panel

WITH the introduction of Mr. E. F. Mann as a new member of PETROLEUM PROCESSING's M&C Panel, we would like to re-introduce the other eleven men who work to bring you information about the latest and best in maintenance and construction methods for petroleum processing plants.
They are:

- Mr. C. C. Carmine, supervisor of maintenance and Construction, Tidewater Oil Co., Associated, Calif.
- Mr. G. B. Snyder, superintendent of bulk operations, formerly superintendent of maintenance, Union Oil Co. of Calif., Wilmington, Calif.
- Mr. J. B. Adams, plant superintendent, U.S. Oil & Refining Co., Tacoma, Wash.
- Mr. C. F. Tennison, maintenance superintendent, Texas City Refining, Inc., Texas City, Texas.
- Mr. E. B. Asmus, central maintenance engineer, Central Engineering Dept., Sinclair Refining Co., East Chicago, Ind.
- Mr. C. D. Carnes, chief engineer, National Petro-Chemicals Corp., Tuscola, Ill.
- Mr. V. J. Loyd, supervisor of the maintenance and corrosion group, Refinery Engineering Div., Socony Mobil Oil Co., Inc., New York, N.Y.
- Mr. H. V. Wilks, manager, engineering and maintenance, Celanese Corp. of America, Bishop, Texas.
- Mr. L. L. Crowl, district superintendent, The Chicago Corp., Carthage, Texas.
- Mr. C. H. Trotter, engineer-in-charge of the maintenance, methods, and equipment section of the Refining Dept., Phillips Petroleum Co., Bartlesville, Okla.
- Mr. R. W. Best, mechanical superintendent, Cities Service Refining Corp., Lake Charles, La.

The above men not only devote time to writing original and constructive M&C feature articles for PETROLEUM PROCESSING, but stand ready to answer interesting and pertinent M&C questions for you. So if you have some M&C problem, send it to:

Maintenance and Construction Editor
PETROLEUM PROCESSING
330 West 42nd Street
New York 36, New York

We'll submit your question to the panel for answering, and let you know as soon as we get answers.

from both directions and the ultimate morale of the whole maintenanec organization depends on how he functions.

The foreman's personal list of roadblocks turns out to be very similar to those of the craftsmen with several pertinent additions such as complaints on operational foremen "dogging him" to get the work done, people adding or subtracting from the work list as the job is progressing, unscheduled meetings, and others.

A similar analysis, if carried on through every level of supervision, soon points out a long list of roadblocks. Obviously good planning and good scheduling of manpower and materials will reduce the effect of many of these roadblocks and possibly eliminate a good many of them completely. This is improvement.

A line supervisor's job should be to carry out plans provided for him, schedule manpower in order to get these plans carried out, and to be general liaison man for the problems of his men and himself so that plans and schedules can remain flexible and workable.

This is a big, important job. This is the job of seeing that the work is done and, if handled efficiently, leaves little time for long-range planning, haggling with other foremen over the importance of work, etc. If we respect his position and don't saddle him with an impossible work load, we can place the "doing" responsibility squarely on his shoulders.

To cut the lost time mentioned in some of the complaints, good long- and short-range planning, scheduling, screening of work requests, screening of plans and schedules, estimating for load carrying ability, and adequate material procurement, are necessary. There is no doubt that these things will improve maintenance regardless of the details of the system used for our specific set of refinery conditions.

The particular system used must be worked up around the existing organization, primarily using existing people and tailored to fit specific needs. Adequate work backlog records must be kept and work assignments balanced so that all are working towards a common top-management established priority.

In a small refinery, much of this can be handled on an informal basis, while in a large refinery more clerical detail is necessary because of the complexity of the operation and the limits of human retention of vital information.

Manpower should be scheduled, in either case 100% (or more—to take care of underestimates of ability) and planned in detail up to 75% to 90% of the scheduled manpower. It is generally uneconomical to formally plan small jobs, say under 8 manhours, these must be handled by special routine job supervision that plans as it proceeds—this accounts for the 10 to 25% difference.

Planning and scheduling must be done on a realistic basis, i.e., a basis of actual work capability rather than someone's idea of what he would like productivity to be. This actual productivity can only be determined as experience and skill in estimating and followup develop, and will vary by locality and from time to time. Impossible goals are useless.

As we improve our planning and scheduling, we improve our "doing" which is what we are really after. However, to realize the extent of our improvement or to determine whether we actually do improve, we must also work to . . .

Improve Our Score Keeping

If we neither know what our work is costing us or care little where our work is being charged, we can have little idea of the effects of any improvement we make.

We should establish goals to shoot for, we should keep track of our progress towards meeting these goals, we should publicize these goals so that each supervisor and worker is aware of his portion in the overall maintenance effort. In other words, we not only should play the game intelligently but should "keep score" as well.

Cost figures are useless if they cannot be used, if they are received too late for effective use, or are just plain not used after they have been finally obtained.

Extreme care must be taken in determining which costs are advantageous and in the timing of the report.

timekeeping, etc. so difficult that the expense of obtaining the figures becomes prohibitive.

Costs should be broken down into service, repairs and alterations. Because service work may be handled on a fixed work order and schedule basis, it may be unnecessary to break it down further. As alterations are usually the most predictable type of work and are similar to construction in approach, each such job can be evaluated by work order segregation only. Repair work, however, warrants close analysis for determination of high cost areas and specific high cost items.

Analysis of these high repair cost areas or equipment items individually may clearly point out where further investigation might reduce these costs by use of better maintenance methods, use of better materials of possibly a change in production procedure.

By analyzing costs in this manner on a manhour basis rather than a dollar basis, it is believed that long-time records will indicate trends of maintenance improvement, will indicate high cost areas, will indicate equipment requiring excessive repairs and will pinpoint the extent of maintenance forces economically required for service work and alterations.

Goals, budgets, and experience records can result from keeping these records and, if they are used diligently, can result in improvement of maintenance through score keeping."

Meet the Author

Mr. Asmus

Mr. E. B. Asmus, central maintenance engineer, Central Engineering Dept., Sinclair Refining Co., E. Chicago, Ind., was born in 1917 at Dorchester, Nebr. In 1940, after receiving a Petroleum Engineering degree (Refining Option) from Colorado School of Mines, he joined Sinclair. His positions with Sinclair have included R&D Technician at Sinclair Refining Co. Development Dept. (now Sinclair Research Co.), and Mechanical and Metals Inspector, Plant Engineer, Mechanical Assistant (maintenance and engineering) and Resident Engineer at Sinclair's Wyoming refinery. In 1953 he returned to the E. Chicago Central Engineering Dept. His present assignment is coordinating maintenance in the seven Sinclair refineries.

The MC Problem Corner
Petroleum Processing's Maintenance and Construction Panel answers your questions in this regular monthly feature.

More On Fast Accounting

. . . Continued from October

Is there a simple, yet complete system for getting maintenance costs (materials and labor) the day after the job is done?

Refining, Gulf Coast

CONTINUING from last month, the M&C panel members have more comments about fast maintenance cost accounting. As mentioned last month, some (but not all) panel members say it is possible to get fast maintenance cost accounting the day after the job is done, still leaving the question, "Is it worth it?"

One panel member reports that there is a complete, but expensive, method of obtaining labor and material costs on work as it is completed. This method also allows a current day-by-day progress report to be kept.

Punched-card tabulating equipment is needed for this method. The tabulator can be used either on a night shift to make results available by 8 a.m. of the following day, or can do the tabulation on a daytime priority basis, making results available by 2 p.m. of the day following the work.

With either method, night shift or daytime priority, it's necessary to get manhour information (time sheet information), material requisitions and consumption records to the tabulating department rapidly. This information can then be set up through punch-card systems to take care of all pricing, extending and reporting.

This panel member continues to say that he knows of no one using this system because of its relatively high cost. However, it often has been considered but abandoned in favor of less expensive, slower reporting methods.

A more commonly used method keeps track of manhour progress of work, as it is being done, through day-to-day work schedules. This schedule, based on past experience, indicates craft manhours already used, those scheduled for the next day, and those anticipated for the complete job. These estimates are kept practical by a continual job progress review as well as a review of job changes. This makes manhours worked factual when compared with time sheets.

Efficient material usage for the job is the responsibility of foreman, material expediters and engineering design personnel. The cost of these materials are seldom kept current job-by-job and day-by-day.

Finally, once a month, dollars-and-cents reports on both labor and material costs on completed work as well as uncompleted work are economically and conveniently available through use of the punch-card tabulating equipment.

An alternate solution, just as good or better than obtaining maintenance costs the day after the job, is being developed by another panel member.

The basis of this alternate method assumes labor manhours to be the main variable, because the material used is usually determined by engineering specifications or refinery practice and can be estimated with fair accuracy.

The method then will compare manhours worked with manhours estimated as a control, and let costs come along at the regular time for accounting jobs only.

IBM accounting machines will be used to get this manhour comparison. Each job is estimated and the information punched on IBM cards that are now used for setting up daily work schedules for each craft. Time sheets for all craftsmen are also prepared every day showing hours worked and job numbers. Manhour information is taken from these time sheets to be punched into the same IBM cards.

When the job is completed, manhours will be machine tabulated, and each day a list of jobs completed the day before will be issued showing estimated and actual manhours by crafts. It is felt that this method will also show jobs beginning to run substantially over manhour estimates while the maintenance work is still in progress.

This manhour comparison should give all immediate control that is needed, and will not bother foremen with job order costs that are 30 to 60 days old and no longer of interest to them.

You have a place at every operation too! All of us oilmen—from exploration men like me to whatever you are—played an important part in the 9,131,545 surgical operations performed last year. We helped supply the doctors with germicides, anesthetics, antibiotics and many of the surgical accessories that help save lives. Unfortunately, too few outsiders know how much oilmen contribute to the health and happiness of the people. Are you doing everything you can to spread the word? It's to your advantage to have your industry understood and appreciated. **SHELL OIL COMPANY**

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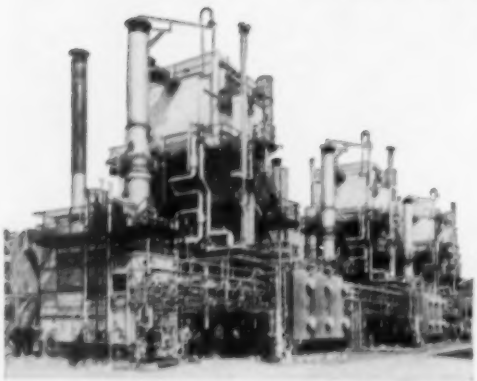

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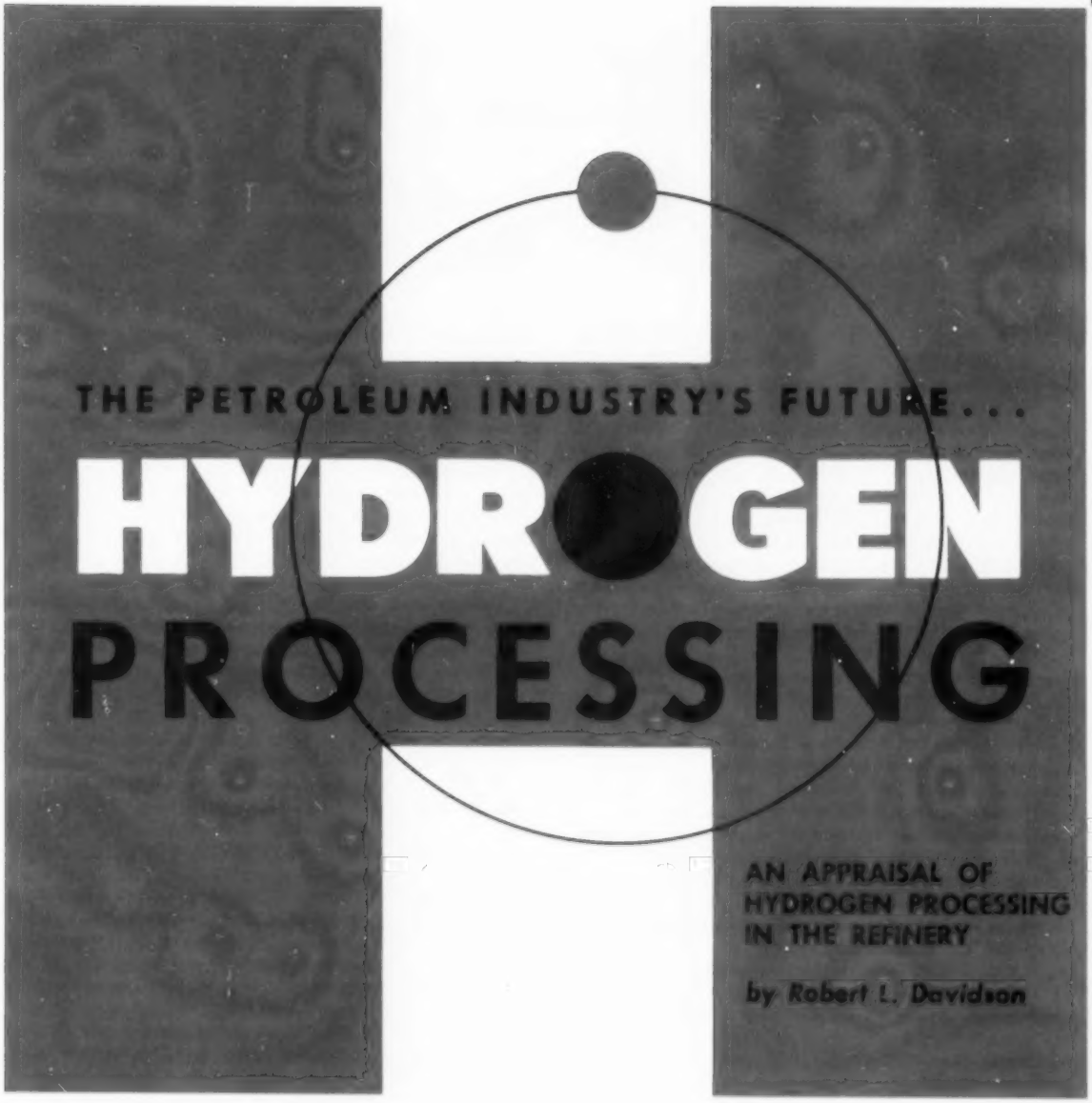

SPECIAL REPORT

Petroleum Processing

NOVEMBER 1956

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What It's All About

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The race to join the hydrogen processing bandwagon promises to eclipse catalytic reforming's spectacular growth rate. With over 944,000 b/d of hydrogen processing capacity expected by the end of 1956, oil companies already have plans for an additional 582,000 b/d capacity during 1957-8, giving a grand total of 1,526,000 b/d—possibly much more.

What is this "not-so-new" technique of treating refinery streams with hydrogen, and why is it just now receiving wide commercial use?

Hydrogen processing is a basically simple process which contacts refinery streams with hydrogen in the presence of a catalyst. Milder hydrogen treating can remove most of the non-hydrocarbons from petroleum (sulfur, nitrogen, oxygen, metals), and convert unsaturated materials into paraffins.

More severe versions convert aromatics into naphthenes, and very severe versions (hydrocracking—cracking plus hydrogenation) can make light distillates out of whole crudes or heavy refinery streams.

Today's main use, however, of hydrogen processing is to pretreat catalytic reformer feed, accounting for over 54% of installed hydrogen processing capacity, and almost 60% of planned capacity.

The second largest use is upgrading cycle and burning oils, accounting for 23% of installed, and 24% of planned capacity. The remaining capacity is for lubes, waxes, solvent naphthas, kerosines, etc.

In the past, process economics were a drag on the commercialization of hydrogen processing. Manufactured hydrogen was too expensive, and 2000-plus psig process pressures required expensive processing equipment.

Cheap hydrogen from catalytic reformer off-gases and process changes to use pressures below 1000 psig have caused hydrogen processing to emerge as one of the major refinery processing tools.

Benefits of hydrogen processing are legion, and will be discussed in more detail on the next page.

Conventional treating often cannot do the job. Acid treating gives large product losses and creates a waste disposal problem. Doctor sweetening converts surfur, but does not remove it. Solutizer, adsorption and other processes will not remove refractory sulfur compounds.

There are 19 processes or process variations for treating refinery streams with hydrogen. The nine available for licensing are described under "Processes You Can Use."

The other 10 processes have limited licensing, or have been developed by oil companies for their own use. More details on these processes will be found at the end of "How Hydrogen Processing Works."

What does the future hold for hydrogen processing? Estimates from a number of sources indicate that hydrogen processing capacity may soon equal 40% of total crude runs. More sour and inferior crudes, and greater product quality demands will require hydrogen processing to upgrade feedstocks, increase process yields, and improve products. Some say hydrogen desulfurization of whole crudes is not far away.

Higher crude or lower hydrogen costs, or a change in fuel markets could make crude or residuum hydrocracking the next big petroleum processing step.

WHERE HYDROGEN PROCESSING CAN HELP YOU...

Better Yields Better Product

Hydrogen processing has many benefits for the petroleum processor. It can reduce non-hydrocarbon impurities in refinery streams, upgrade poor feedstocks and low-grade products, and reduce equipment corrosion by removing sulfur. Some outstanding hydrogen processing uses are discussed below.

Feedstock Preparation

Hydrogen processing of feedstocks can increase process yields, enhance catalyst activity and life, improve ultimate product qualities, and prepare "unsuitable" feedstocks for catalytic processing.

Catalytic reformer feedstock pretreatment is the biggest use of hydrogen processing. It helps fixed-bed reformers, with platinum-containing catalysts, to perform better and longer.

Excess sulfur, nitrogen or metals in cat reformer feedstock will suppress, or poison, platinum catalysts. Therefore, hydrogen processing is used to clean-up dirty reforming stocks.

"Refiners were caught with their 'unawares' down," said the research director for one large oil company. "We planned hydrogen pretreat of dirty feedstock. But now we have found that even small amounts of sulfur in relatively clean feedstocks will form iron sulfide scale that plugs the catalyst bed. Now we plan hydrogen pretreaters for all of our cat reformers."

Another plus for hydrogen processing is hydrogen-saturation of olefinic thermal naphthas that ordinarily could not be used to any great extent in cat reformer feedstock. The hydrogen-saturated material makes an excellent feedstock for cat reformers, increasing the refinery's overall yield of high octane gasoline.

Catalytic cracking can also benefit from hydrogen processing to convert refractory sulfur compounds and conjugated aromatics. Refractory sulfur materials, usually cyclic compounds, are not removed by caustic treat, and even coking will not break some of them.

Most of the cyclic sulfurs concentrate in the heavy cycle oil, which can be desulfurized by hydrogen processing. This requires less hydrogen then desulfurization of the total fresh gas oil feed to the cracker, and gives a cat gasoline with greatly reduced sulfur.

Refractory, conjugated aromatics (multi-ring compounds) in heavy cycle oil crack to coke when this material is recycled to the reactor. A selective, partial hydrogenation of these conjugates reduces their refractoriness, resulting in less coke when the heavy cycle oil is recycled for further cracking.

Because the capacity of most catalytic cracking units is limited by the ability to burn coke from the catalyst during regeneration, hydrogenation of heavy cycle oil allows several per cent more cat gasoline yield at the maximum allowable coke rate.

Product Upgrading

Uses of hydrogen processing for products are legion. In general, hydrogen can take an inferior product and upgrade it to compare very favorably with "sweet-virgin" quality.

Middle distillates offer the largest field for hydrogen processing of products. Here, hydrogen can make premium quality fuel oils from coker, cracker, straightrun, vacuum and heavy gas oils.

Thermally cracked distillates, which are difficult to market because of poor color and stability, can be hydrogen processed to reduce sulfur and carbon residue, and improve color, odor, phenol and neutralization numbers.

Hydrogen processing replaces acid treating of heavy cracked heating oils, and conversion sweetening of virgin heating oils (which tends to increase carbon residue).

Diesel oils can be made from catalytically cracked gas oils by hydrogen processing for better cetane and bromine numbers, gravity, stability, and color; and reduced sulfur, olefin content and carbon to hydrogen ratio. More severe treatment converts aromatics to naphthenes, while less severe treatment merely reduces sulfur.

Kerosines from sour crudes can be hydrogen processed to meet the strict specifications of insecticide manufacture. Sulfur is reduced, and color, odor and wick char are improved.

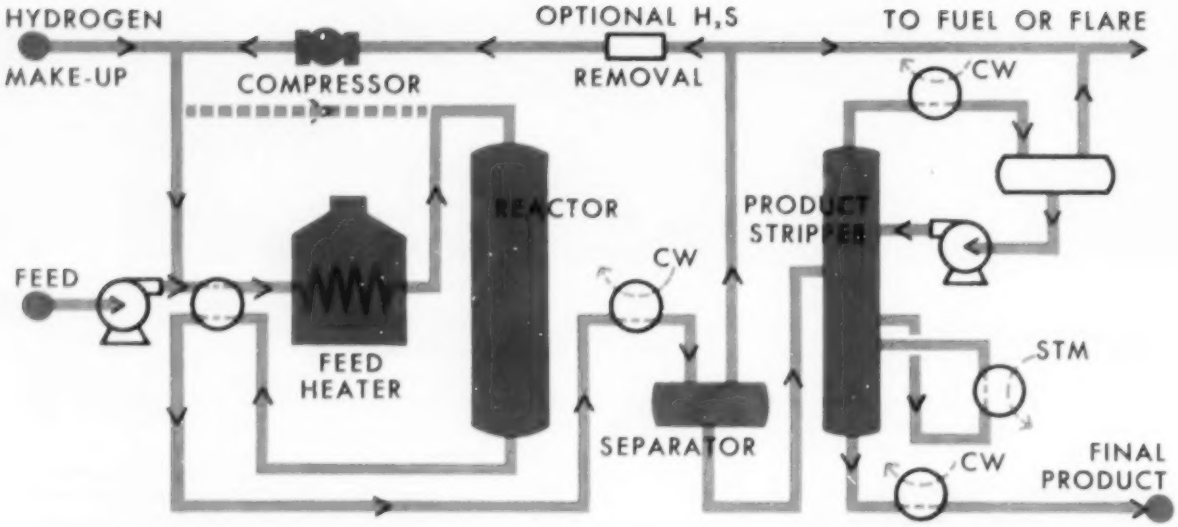
Lubricating oils are improved by mild hydrogen processing to convert color bodies to improve color and color stability, with little change in other properties. More severe hydrogen processing will remove sulfur and hydrogenate unsaturated compounds.

Hydrogen processing of lubes can be considered a replacement for acid treating of second-line naphthenic lube stocks, and clay finishing for premium extracted motor oils.

Gasolines, motor and aviation, can be improved by hydrogen processing. Motor fuels from catalytic and thermal cracked naphthas have better stabilities and give better engine cleanliness with little or no leaded octane loss after mild hydrogen processing.

Aviation gasolines from cat cracked gasoline stocks have better stabilities and lean-mixture leaded octanes when hydrogen processed to reduce sulfur and hydrogen-saturate olefins. Rich-mixture leaded octane, dependent on aromatics content, is not affected by hydrogen processing.

Waxes from Panhandle and Salt Flat crudes, made by sweating and percolation, darken at elevated temperatures and light exposure, also develop a bad odor and taste. Hydrogen processing overcomes these shortcomings, making premium waxes.



HYPOTHETICAL HYDROGEN PROCESSING UNIT combining typical features of several of today's licensed processes for hydrogen processing of refinery streams.

How Hydrogen Processing Works

Hydrogen processing is a general term for refinery processes using hydrogen to pretreat, upgrade, finish, or convert petroleum fractions. Within this definition are the specific terms of:

- **Hydrogen treating**—all common uses of Hydrogen processing except Hydrocracking.
- **Hydrodesulfurization**—rupture of carbon-sulfur bonds, with hydrogenation of free valency.
- **Hydrogenation**—adding hydrogen to a hydrocarbon molecule with no basic structure change.
- **Hydrocracking**—also called Destructive Hydrogenation and Hydrogenolysis—pyrolysis and hydrogenation of ruptured bond taking place before and/or after cracking the molecule.

Using hydrogen to treat refinery streams is not new. Early in the century, I.G. Farbenindustrie pioneered solid fuels hydrogenation, later the basis of Hitler's oil-from-coal program. Following World War II, West German hydrogenation units were converted to give 28,000 b/d of crude residual hydrocracking capacity.

In the United States, Esso Standard Oil Co. had high-pressure (3000+ psig) hydrogenation and hydrocracking plants in operation at Baton Rouge, La. and Bayway, N. J. in the 1930's. A third, lower pressure (750 psig) unit was operated for the Defense Plants Corp. by Humble Oil & Refining Co. at Baytown, Texas, during World War II.

Another World War II use of hydrogen processing was the hydrogenation of isobutylene-butylene polymer (octenes) to make pure iso-octane aviation gasoline. Shell Development Co. was a pioneer in this work. Also, hydrogen processing was used to saturate cat cracked aviation base stock (to improve stability and leaded octane), and hydrocrack special cyclic-containing kerosines (to make aviation gasoline base stock).

Hydrogen Processing Today

The biggest use for hydrogen processing is desulfurization. High-sulfur crudes are becoming more common in the U. S. These crudes are high in refractory sulfur compounds (thiophenes and thiophanes), largely unaffected by acid treating, silica gel or bauxite adsorption, doctor treating, and caustic-tannin processes.

Hydrogen processing easily removes all sulfur, nitrogen and oxygen compounds, and some metals.

Process Flow

The above general flow diagram shows the most important points of today's licensed processes. Feedstock is preheated, either before or after being mixed with make-up and recycle hydrogen. The feedstock-hydrogen mixture then enters the fixed-catalyst-bed reactor.

Reactor effluent is cooled, then separated. Hydrogen-rich separator gas recycles to the reactor, and can be amine scrubbed if hydrogen sulfide is too high.

Separator liquid is stripped to remove remaining hydrogen sulfide and light ends. Stripper bottoms are the final, hydrogen processed product.

Wide-cut feedstocks (i.e., naphtha-stove oil mixture) need additional product separation equipment. Stripper and unrecycled separator gases can be flared, used as refinery fuel, or sent to sulfur recovery.

Process Reactions

Some common hydrogen processing reactions (desulfurization, denitrification, deoxygenation, olefin and

diolefin saturation, and hydrocracking) are shown below.

The most common impurities in refinery streams are sulfur compounds, followed by nitrogen, then oxygen compounds. Reactions with hydrogen form hydrogen sulfide, ammonia, and water, respectively.

Mercaptans are more easily reacted with hydrogen than refractory, cyclic sulfur compounds. Diolefins are easier to hydrogen-saturate than olefins, which in turn saturate easier than conjugated and simple aromatics.

Lube oil color bodies can be converted by mild hydrogen processing, either with or without desulfurization and hydrogenation of unsaturates.

Metals, such as vanadium, arsenic and sodium, are removed, apparently by the formation of metal hydrides.

Hydrogen processing of thiophene, pyridine and pyrrole (shown below) are examples of the formation of new compounds, explaining 100+% volumetric yields.

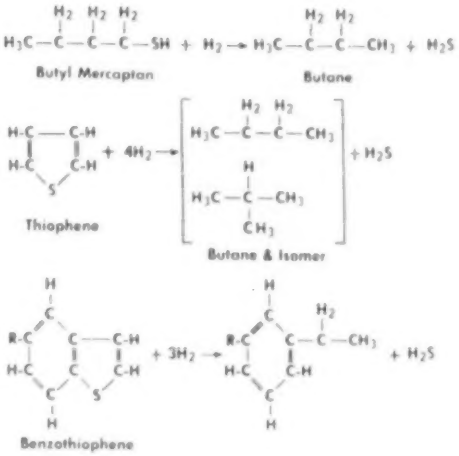
Hydrocracking differs from hydrogenation, and forms new, lighter compounds by combined cracking and hydrogenation.

Operating Conditions

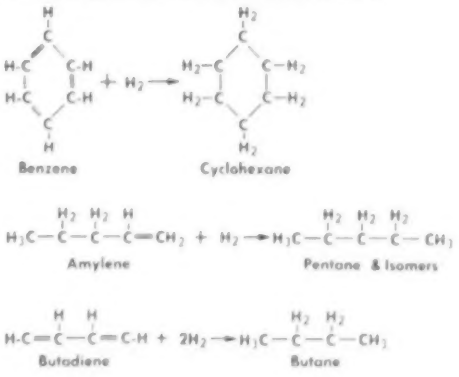
Hydrogen treating conditions are relatively mild, but vary widely with catalyst, feedstock and purpose.

Typical ranges are 50-1500 psig, 400-850°F, H_2 cir-

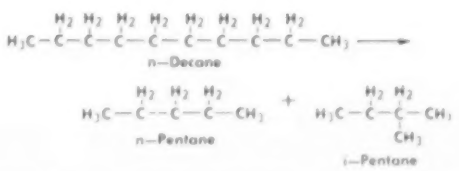
DESULFURIZATION REACTIONS



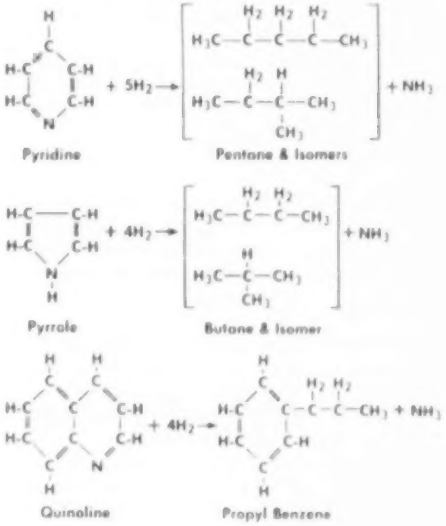
HYDROGEN-SATURATION REACTIONS



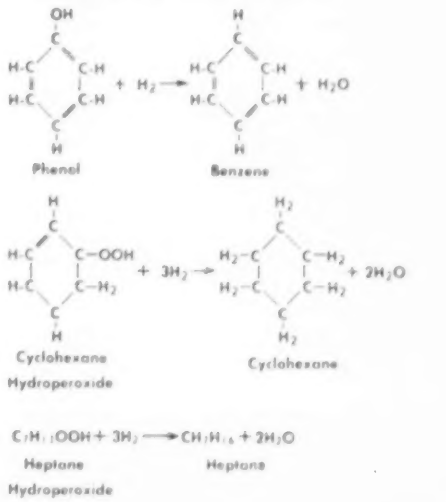
HYDROCRACKING REACTION



DENITRIFICATION REACTIONS



DEOXYGENATION REACTIONS



culation of 200-5000 SCF/bbl, and space velocities of 0.5-20 volumes oil/hr/volume catalyst.

Pressures below 1000 psig are usually adequate, but must be sufficient to stop formation of coke, tars, and polymers.

Temperatures start low, and are increased during the process cycle as the catalyst loses activity. Hydrogen circulation rates are set to stop catalyst deactivation, and supply hydrogen used in the reaction. Space velocities can be as high as 20 for mild treating, or less than one for stubborn treating problems.

Stocks boiling under 500°F are usually treated in the vapor-phase. If there is even a small liquid phase, the process is called liquid-phase, reaction rates drop and catalyst loses activity faster.

Hydrogen for Processing

Catalytic reformer off-gas is the most widely used source of hydrogen processing hydrogen. Other sources are manufactured hydrogen and tail gases from butadiene and ethylene plants.

Total diluents should not be much over 25-30 mol% (50 mol% in some cases), a figure met by most catalytic reformer off-gas streams. Too dilute a hydrogen stream reduces catalyst activity.

Carbon monoxide and carbon dioxide diluents consume hydrogen. Inerts (argon and nitrogen) build-up in recycle to reduce hydrogen partial pressure, therefore, must be removed.

Several per cent of hydrogen sulfide can be tolerated in the recycle hydrogen stream without harm.

Hydrogen Treating Catalysts

The most widely used catalyst is cobalt molybdate on an alumina carrier. While either cobalt oxide and/or molybdenum trioxide are active catalysts, pioneer work by Union Oil Co. of Calif. showed the superiority of the cobalt molybdate compound.

There are many possible catalyst and carrier combinations, but cobalt molybdate on alumina owes its popularity to good activity, selectivity, long life, insensitiveness to poisons, strength and low cost.

Catalysts Regeneration

Regeneration of hydrogen processing catalysts is simple and effective, returning the catalyst to a virgin activity and cycle life.

Burning *in situ* removes carbon, the main catalyst deactivant. Air is diluted to 1-2% by live steam or flue gas, and preheaed to 650-750°F. The regeneration temperature is kept below 1200-1400°F to prevent permanent impairment of catalyst activity.

Total regeneration time can range from 10 hours up to 3-4 days, and is affected by unit size, availability of air and flue gas or steam, and allowable catalyst bed pressure drop.

Ten or more regenerations appear possible (one licensor predicts 50-100) with an ultimate catalyst life of 2-5 years. Attrition, more than poisoning, appears to determine catalyst life.

Onstream cycles between regenerations can be 1-12 months, depending upon many factors.

Hydrogen Treating Equipment

Most equipment for hydrogen treating units meets conventional refinery specifications for similar units. However, in areas above 500°F, alloy steels are needed to resist hydrogen and/or hydrogen sulfide attack. Hydrogen attack itself, though, is rarely a problem with hydrogen partial pressures below 200 psi.

Reactors can be of carbon or carbon-molybdenum steels, lined with castable refractory and insulating cements. In high-pressure-drop units, a stainless steel or aluminized low-chrome steel liner can be used to stop by-passing of reactants through the cements.

Hydrocracking

Hydrocracking is a combination of cracking, or pyrolysis, with hydrogenation of free valencies before and/or after the hydrocarbon is cracked.

Feedstocks can include whole crudes, residua, tars, and asphalts, which can be processed to give a 110-120 vol% yield of cat reformable gasoline-range material.

High capital costs ($800-1000/bbl) for the 3,000-10,000 psig equipment, and high hydrogen consumptions (2000-5000 SCF/bbl) make hydrocracking costly.

Limited hydrocracking, such as the Gulf HDS process, is more likely to find early use in the U. S.

Economics

Hydrogen treating units cost $50-250/bbl of capacity, depending on feedstock and extent of processing. Operating costs vary widely.

Typical investment and operating costs, and utilities demands, are given in the process descriptions, under "Processes You Can Use."

Miscellaneous Processes

In addition to the processes described in detail later in this report, others have received public attention.

British Petroleum Co. Ltd. has its Hydrofining and Autofining processes, the latter generating its own hydrogen supply. There are no U. S. or Canadian units.

The Houdry Process Corp. uses either Houdriforming or cobalt-molybdenum catalysts as a Guard Case for Houdriformers, and M. W. Kellogg installs cobalt-molydenum feed pretreaters for catalytic reformers.

Several U. S. oil companies have hydrogen processing methods for which there are no licensing plans. These are Socony Mobil Oil Co. (Sovafining and hydrocracking to make jet fuels), Gulf Oil Corp. (Gulfining), The Texas Co. Richfield Oil Corp., Ashland Oil & Refining Co., Phillips Petroleum Co., Sun Oil Co. (lube finishing), and Sinclair Refining Co. (lube finishing).

Humble Oil & Refining Co. has just recently announced a new process for hydrocracking tars into distillates.

WANT MORE DETAILS?

Licensed process descriptions start.....p. 125

Commercial catalyst descriptions start.....p. 134

WHAT CAN WE EXPECT FROM

Tomorrow's Hydrogen Processing

Now that hydrogen processing has "awakened" from its decades of "dormancy," far-seeing oil men envision a much greater role for hydrogen than mere feedstock pretreating and product upgrading.

Hydrocracking heavy petroleum fractions into lighter, more valuable products is a tried and proven technique. It needs only more favorable economics to blossom into large-scale use in the U. S.

Though no one can say when hydrocracking will be an accepted refinery process, a dramatic change in world crude supplies—or world politics—could force the acceptance of petroleum hydrocracking as a standard refinery process.

As one oil man said, "If crude costs, or motor fuel values rise enough, we'll toss home and industrial heating back to the coal people. Then we can convert the whole barrel of crude into motor and aviation fuels by a process such as hydrocracking."

Limited hydrocracking of whole crudes, however, seems more likely in the not too distant future than complete hydrocracking.

Some Western Canadian crudes, more like molasses than oil, are too sour and viscous to pipeline, and too remote to refine. Mild hydrocracking would reduce sulfur and increase gravity so that this crude could be pipelined to refining centers. Here again, however, world crude economics are controlling.

Desulfurization of whole crudes, without hydrocracking, might be a more immediate step in hydrogen processing. More than one oil company is said to be serious about crude desulfurization prior to pipelining, with at least one installation possible before 1960.

Whence the Hydrogen?

Hydrogen from catalytic reformers will probably satisfy most feedstock pretreatment and product upgrading needs. However, now that oil men have a taste of what hydrogen can do to refinery streams, they find more and more "wonderful" things to do with hydrogen.

Hydrocracking, the most spectacular of the hydrogen processing techniques, can consume 100 times the hydrogen needed to pretreat straightrun naphtha for catalytic reforming. For hydrocracking, another outside source of hydrogen is needed.

The cost of manufactured hydrogen has usually been considered too high for hydrogen processing. In fact, this is the reason that large-scale hydrogen processing had to await the advent of cheap hydrogen-rich catalytic reformer off-gas.

Several self-hydrogen-generating processes have been proposed to circumvent the need for an outside hydrogen source. Pioneer in this work is the British Petroleum Co. Ltd. with Autofining. This process simultaneously dehydrogenates feedstock naphthenes to make hydrogen, which is used to hydrogen treat the remainder of the feed.

Another approach by Esso Research & Engineering Co. (U.S. Patent 2,440,673—1948) uses city, coke oven, or water gas with as low as 30% hydrogen to treat naphthas.

A recent Texaco hydrocracking patent (U. S. 2,739,-929—1956) suggests mixing iron and water with the oil to be hydrocracked. The iron and water react to make the hydrogen needed to sustain the hydrocracking reaction.

The arbitrary "fuel-gas" value for reformer hydrogen no longer holds in many refineries. Hydrogen processing and ammonia manufacture automatically upgrade the value of this hydrogen stream to a new level, determined by profitability of its new use—not a psuedo fuel gas use.

As proof of the "new value" for reformer hydrogen, more than one refiner has found that supposedly expensive manufactured hydrogen is just as cheap as low-cost reformer hydrogen—when there is no more reformer hydrogen aavilable for new hydrogen processing or petrochemical applications.

This need for a new look at manufactured hydrogen costs prompted PETROLEUM PROCESSING to contact several licensors of hydrogen manufacturing processes.

Specific refinery economics will dictate the choice of feedstock and process for hydrogen manufacture. Almost any refinery stream can be the feedstock but, conversion and purification problems limit the choice. The major processes in use today are catalytic steam reforming, and non-catalytic partial oxidation of hydrocarbon streams.

While hydrogen purification is needed for hydrogen processing uses, requirements are not as stringent as for ammonia manufacture, hence the result is a cheaper hydrogen.

One company, The Girdler Co., has furnished the following information on hydrogen manufacture. The cost of manufactured hydrogen is roughly 2.5-4 times its fuel value in the plant, depending on the feedstock value. An example for steam reforming natural gas or a light hydrocarbon to make 20 MMSCF/day hydrogen, using a feedstock valued at $0.10/MMBtu is as follows:

	$/MMSCF of Hydrogen
Process feed and fuel	46.70
Cooling water	4.63
Water make-up	0.46
Power	8.71
Catalyst	4.10
Operating and maintenance labor	15.06
Operating and maintenance supplies	23.59
Supervision and control	8.90
Fixed cost	24.90
Total cost, $/MMSCF of hydrogen	**137.05***

*If feedstock cost is $0.20/MMBtu, total is $183.65/MMSCF; if feedstock $0.30, total is $230.35.

Where Hydrogen Processing is

The following comprehensive list of hydrogen processing installations in the United States and Canada is the fruit of an exhaustive mail survey made by the editors of PETROLEUM PROCESSING to present the complete picture.

The 142 installations listed below, both existing and planned, which range from 450 to 50,000 b/d, have an average capacity of about 10,750 b/d.

The rate of completions and new units scheduled indicate that previous predictions of future capacity of hydrogen processing facilities will have to be revised upward. The 1.5-million b/d of installed hydrogen processing capacity expected previously to be installed by 1960, will most probably be reached by the end of 1958. Present onstream capacity is 744,000 b/d.

	COMPANY, LOCATION	CAPACITY	PROCESS, LICENSOR	STATUS	APPLICATION
A	American Oil Co., Yorktown, Va.	22,600	HD/SI	early '57	desulf & olefin sat. of virgin & cracked naph. & gas oil
	Texas City, Tex.	23,000	HD/SI	onstream	desulf of heavy virgin naphtha
	Texas City, Tex.	21,000	HD/SI	sched '58	desulf of virgin & cracked naphthas to ultraformer
	Anderson-Prichard Oil Corp., Cyril, Okla.	1,000	UN/UN	onstream	purify Catformer feed
	Ashland Oil & Refining Co., Canton, Ohio	8,500	PRIVATE	early '57	desulf & denitrif of reformer feed stock and naphthas
	Catlettsburg, Ky.	8,500	PRIVATE	onstream	desulf & denitrif of reformer feed stock and naphthas
	Aurora Gasoline Co., Detroit, Mich.	7,700	UN/UOP	onstream	desulf, denitrif & olefin sat. of atm. & vac. gas oils & therm. cracked naph.
	Muskegon, Mich.	750	UN/UOP	onstream	desulf, denitrif & olefin sat. of therm. naph. to Platformer
C	Carter Oil Co., Billings, Mont.	6,900	HF/ERE	onstream	reduce sulfur & increase yield of virgin diesel fuel
	Col-Tex Refining Co., Colorado City, Tex.	1,800	UN/UOP	onstream	purify feed to Platformer
	Continental Oil Co., Billings, Mont.	7,375	UN/UN	onstream	desulf. to meet product specs.
	Ponca City, Okla.	16,000	Kellogg	late '57	desulf, remove chlorine and metals from cat. reformer feed
	Cooperative Refinery Assn., Coffeyville, Kans.	3,000	UN/UOP	onstream	desulf & sat. of light cycle oil & coker distillate
	Phillipsburg, Kans.	3,500	UN/UOP	planned	desulf & metals removal from naphtha to Platformer
	Cosden Petroleum Corp., Big Spring, Tex.	2,100	UN/UOP	onstream	desulf & non-hydrocarbons removal from SR naph. to Plat.
	Crown Central Petroleum Corp., Houston, Tex.	5,000	Houdry	onstream	desulf of Houdriformer feed
D	Delhi-Taylor Oil Corp., Corpus Christi, Tex.	14,000	UN/UOP	mid '57	Platformer feed pretreatment
	Derby Refining Co., Wichita, Kans.	4,000	HD/SI	onstream	desulf (& olefin sat. if desired) of SR naph. to Ultraformer
	Douglas Oil Co., Bakersfield, Calif.	1,300	UN/UN	sched '57	desulf, denitrif & olefin sat. of high sulfur SR & P. D.
	D-X Sunray Oil Company, Duncan, Okla.	9,300	UN/UOP	planned	desulf, olefin sat. & decontamination of cat. reformer feed
	Duncan, Okla.	6,000	UN/UOP	planned	desulf & decontamination of catalytic reformer feed
	Duncan, Okla.	12,000	UN/UOP	late '57	desulf & olefin sat. of coker dist. & gas oil, and cat. hvy. recycle
	Tulsa, Okla.	20,000	UN/UOP	planned	desulf & olefin sat. of gasoline for improved product yields
	Tulsa, Okla.	12,000	UN/UOP	late '57	desulf & olefin sat. of coker dist. & gas oil, light & hvy. cat. cycle oil
E	Eastern States Petroleum Co., Inc., Houston, Tex.	10,000	UN/UN	onstream	desulf & olefin sat. of gasoline, naphtha and gas oil
	Houston, Tex.	16,000	UN/UN	onstream	desulf & olefin sat. of gasoline, naphtha and gas oil
	Elk Refining Co., Falling Rock, W.Va.	500	UN/UOP	onstream	desulf & olefin sat. of solvents, kero., therm. cracked gaso. & reformer feed
	Esso Standard Oil Co., Baltimore, Md.	12,000	HF/ERE	onstream	desulf, RSH removal, olefin sat. of light virgin, hvy. cat & coker naphthas
	Baltimore, Md.	3,000	HF/ERE	onstream	desulf of heavy virgin naphtha as Powerformer feed
	Baltimore, Md.	5,000	HF/ERE	onstream	desulf, odor & stabil. improv. of hvy. cat. & virgin heating oil
	Baton Rouge, La.	3,600	HF/ERE	planned	improve odor of solvent naphtha
	Baton Rouge, La.	26,900	HF/ERE	in design	desulf of virgin naphtha for Powerformer feed
	Bayonne, N.J.	2,500	HF/ERE	onstream	improve color, odor & USP Acid for wax
	Everett, Mass.	7,250	HF/ERE	in design	desulf Powerformer feed, 10% coker naph., 90% virgin naph.
	Linden, N.J.	7,640	HF/ERE	onstream	diolefin sat., improve odor & stabil. of therm. hvy. naph.
	Linden, N.J.	19,520	HF/ERE	onstream	improve odor, reduce Con Carbon of catalytic heating oil
	Linden, N.J.	23,000	HF/ERE	mid '57	desulf of virgin naphtha for Powerformer feed
	Linden, N.J.	15,000	HF/ERE	late '57	desulf of light virgin naphtha
F	Famariss Oil & Refining Co., Hobbs, N.M.	1,000	UN/UOP	onstream	desulf 160/390°F naphtha feed to Platformer
	Farmers Union Central Exchange, Laurel, Mont.	3,500	UN/UOP	1957-58	desulf straightrun naphtha, No. 1 burner oil & diesel oil
	Frontier Oil Refining Co., N. Tonawanda, N.Y.	8,500	PRIVATE	late '56	desulf and denitrif of cat. reformer feedstock and naph.

Used or Planned in Refining

Key to Process Names and Licensors

DF/HO	Diesulforming/Husky Oil Co.
HD/SI	Hydrodesulfurization/Standard Oil Co. (Ind.)
HF/ERE	Hydrofining/Esso Research & Engineering Co.
Houdry	Houdry Process Corp. Guard Case. usually licensed with Houdriformers.
Kellogg	Unlicensed process available from M. W. Kellog Co.
ST/SH	Shell Trickle Hydrodesulfurization /Shell Development Co.
SV/Sh	Shell Vapor-Phase Hydrodesulfurization/ Shell Development Co.
UN/UN	Unifining/Union Oil Co. of Calif.
UN/UOP	Unifining/Universal Oil Products Co.

	COMPANY, LOCATION	CAPACITY	PROCESS, LICENSOR	STATUS	APPLICATION
	Frontier Refining Co., Cheyenne, Wyo.	2,500	UN/UOP	onstream	desulf of cat. light cycle stock & straightrun dist.
G	Golden Bear Oil Co., Oildale, Calif.	500-750	UNDEC.	not known	esulf & aromatic saturation of several streams
	Great Northern Oil Co.,				
	Pine Bend, Minn.	13,000	HD/SI	onstream	desulf naphtha
	Pine Bend, Minn.	3,000	HD/SI	bldg.	desulf No. 1 and No. 4 fuel oils
	Gulf Oil Corp., Port Arthur, Tex.	22,500	PRIVATE	late '56	desulf & olefin sat. of cat. & SR furnace oil dist.
	Port Arthur, Tex.	22,500	PRIVATE	late '56	desulf & olefin sat. of cat. & SR furnace oil dist.
	Philadelphia, Pa.	22,500	PRIVATE	late '56	desulf & olefin sat. of cat. & SR furnace oil dist.
	Philadelphia, Pa.	22,500	PRIVATE	late '56	desulf & olefin sat. of cat. & SR furnace oil dist.
H	Hancock Oil Co., Long Beach, Calif.	3,000	HD/SI	onstream	desulf of mixed virgin & therm. naph. for cat. reformer
	Humble Oil & Refining Co.,				
	Baytown, Tex.	18,000	HF/ERE	onstream	desulf & improv. of virgin & therm. cracked gas oils
	Baytown, Tex.	18,000	HF/ERE	onstream	desulf & improv. of virgin & therm. cracked gas oils
	Baytown, Tex.	18,000	HF/ERE	onstream	desulf & olefin sat. of hvy. thermal & cat. naphthas
	Baytown, Tex.	8,880	HF/ERE	onstream	color stab. & naphthenic acid destruc. of coast. lube dists.
	Baytown, Tex.	8,000	HF/ERE	planned	desulf of mineral spirits & turbo fuel components
	Baytown, Tex.	40,000	HF/ERE	late '57	desulf of light virgin naphtha for cat. reformer feed
	Baytown, Tex.	50,000	HF/ERE	planned	catalytic cracker feed desulfurization
	Husky Oil Company, Cody, Wyo.	1,000	DF/HO	onstream	desulf & upgrading of dist. or gas oil or combination
I	Indiana Farm Bureau Co-op Assn., Inc.,				
	Mt. Vernon, Ind.	2,100	UN/UOP	onstream	desulf of thermal side cut-cat, cycle oil
	International Refineries, Inc.,				
K	Wrenshall, Minn.	2,800	HF/ERE	late '56	desulf of hvy. naphtha for Powerformer feed
	Kendall Refining Co., Bradford, Pa.	2,600	UN/UOP	early '57	desulf and clean-up of Platformer feed
L	Leonard Refineries, Inc., Alma, Mich.	2,400	HD/SI	onstream	desulf of Ultraformer feed
	Alma, Mich.	3,800	HF/ERE	onstream	desulf of vacuum gas oil, cylinder stock
	Alma, Mich.	1,400	HF/ERE	onstream	desulf of No. 1 fuel oil
	Mt. Pleasant, Mich.	450	(1)/UOP	onstream	desulf & olefin sat. of aromatic distillate
	Louisville Refining Co., Louisville, Ky.	2,000	UN/UOP	early '57	desulf & upgrade 225/400°F naphtha Platformer feed
M	Magnolia Petroleum Co.,				
	Beaumont, Tex.	25,000	PRIVATE	sched '57	desulf & sat. of naphtha Sovaformer feed
	Beaumont, Tex.	30,000	PRIVATE	early '58	desulf & stabil. light virgin & cat. gas oil, sour kero.
	Mohawk Petroleum Corp.,				
	Bakersfield, Calif.	925	UN/UN	planned	desulf, denitrif, olefin & diolefin sat. of hvy. therm. gaso.
O	Ohio Oil Co., Robinson, Ill.	8,000	Houdry	onstream	desulf & arsenic removal from 240/410°F naph. to Houdriformer
P	Pan-Am Southern Corp.,				
	El Dorado, Ark.	11,500	HD/SI	mid '57	desulf & olefin sat. of straightrun & cracked naph.
	Phillips Petroleum Co., Phillips, Tex.	10,000	PRIVATE	onstream	desulf, olefin sat. & color stab. of naphthas & kerosene
	Premier Oil Refining Co.,				
	Gregg County, Tex.	1,500	UN/UOP	early '57	desulf, denitrif & olefin sat. of therm. cracked naphtha for Platformer feed
	Pure Oil Co., Newark, Ill.	3,000	Kellogg	onstream	desulf of naphtha catalytic reformer feed
	Lemont, Ill.	18,000	Kellogg	planned	desulf straightrun gasoline
	Nederland, Tex.	20,000	HD/SI	late '56	desulf straightrun gasoline
R	Richfield Oil Corp., Wilmington, Calif.	17,000	PRIVATE	onstream	desulf & denitrif of catalytic reformer feed
	Wilmington, Calif.	6,000	PRIVATE	onstream	gum reduction of heavy catalytic gasolines
	Rock Island Refining Corp.,				
	Indianapolis, Ind.	5,000	UN/UOP	early '57	preparation of straightrun gasoline for Platformer
S	Shamrock Oil & Gas Corp.,				
	Sunray, Texas	5,000	UN/UOP	onstream	desulf straightrun gasoline (Platformer feed) & kerosene
	Shell Oil Co., Anacortes, Wash.	8,000	SV/Sh	onstream	desulf & denitrif of straightrun naph. for cat. reforming
	Houston, Tex.	16,000	SV/Sh	onstream	desulf & denitrif of SR & therm. naph. for cat. reforming
	Wilmington, Calif.	12,000	SV/Sh	onstream	desulf, denitrif, diol. sat., improve stab. of cat. & therm. cracked naph.

(1) *Platreating*

COMPANY, LOCATION	CAPACITY	PROCESS, LICENSOR	STATUS	APPLICATION
Wood River, Ill.	11,000	SV/Sh	onstream	desulf, improve odor & color stab. of SR naph. & dist. fuels
Wood River, Ill.	16,000	SV/Sh	late '56	desulf & denitrif of SR & therm. naph. for cat. reforming
Sinclair Refining Co., East Chicago, Ill.		PRIVATE	planned	lube oil finishing (details not given by company)
Houston, Tex.	24,000	PRIVATE	onstream	desulf of crude still naphtha for catalytic reformer
Houston, Tex.	12,000	PRIVATE	late '57	desulf of fluid cycle oil
Houston, Tex.	12,000	PRIVATE	late '57	desulf of straightrun heating oil
Marcus Hook, Pa.	10,000	PRIVATE	onstream	desulf of fluid catalytic cycle oil
Socony Mobil Oil Co., Inc.,				
Buffalo, N.Y.	9,000	PRIVATE	onstream	desulf of straightrun naph. for Sovaformer
Casper, Wyo.	4,600	PRIVATE	late '57	desulf & sat. of SR & therm. naph. for Sovaformer
East Chicago, Ind.	13,300	PRIVATE	onstream	desulf & sat. of SR & therm. naph. for Sovaformer
East St. Louis, Ill.	16,000	PRIVATE	early '57	desulf & sat. of SR & therm. naph. for Sovaformer
Paulsboro, N.J.	20,000	PRIVATE	onstream	desulf & sat. of SR & therm. naph. for Sovaformer
Paulsboro, N.J.	22,000	PRIVATE	mid '57	desulf & stabilization of sour No. 2 fuel oil components
Trenton, Mich.	9,000	PRIVATE	onstream	desulf & sat. of SR & coker naph. for Sovaformer
South Penn Oil Co. (Pennzoil Div.),				
Rouseville, Pa.	2,000	UN/UOP	onstream	Platformer feed (details not given by company)
Standard Oil Co. (Calif.),				
Richmond, Calif.	22,000	UN/UOP	onstream	desulf of straightrun & cracked gasoline fractions
El Segundo, Calif.	22,000	UN/UOP	onstream	desulf of straightrun & cracked gasoline fractions
Standard Oil Co. (Ind.), Casper, Wyo.	5,200	HD/SI	onstream	desulf & olefin sat. of virgin naphtha for Ultraformer
Sugar Creek, Mo.	21,000	HD/SI	onstream	desulf & olefin sat. of virgin naphtha for Ultraformer
Whiting, Ind.	5,600	HD/SI	stand-by	desulf of heater oil
Whiting, Ind.	21,000	HD/SI	onstream	desulf & olefin sat. of virgin naphtha for Ultraformer
Whiting, Ind.	30,000	HD/SI	mid '57	desulf & olefin sat. of virgin naphtha for Ultraformer
Wood River, Ill.	15,000	HD/SI	late '56	desulf & olefin sat. of virgin naphtha for Ultraformer
Standard Oil Co. (Ohio), Lima, Ohio	13,000	(2)/UOP	onstream	prep. of Platformer feed (12,000 b/d), & stove oil (1,000 b/d)
Cleveland, Ohio	13,000	HD/SI	onstream	desulf, denitrif & olefin sat. of 200/400°F virgin & thermal naph. for Ultraformer
Sun Oil Company, Marcus Hook, Pa.		PRIVATE	onstream	lube oil finishing (details not given by company)
Suntide Refining Co.,				
Corpus Christi, Tex.	15,000	UN/UOP	mid '57	pretreatment of virgin naphtha for Rexformer
T Texas Co., The, Westville, N.J.	6,500	PRIVATE	onstream	desulf of catalytically cracked distillate
Wilmington, Calif.	10,000	PRIVATE	onstream	desulf & olefin sat. of heavy cracked gasoline
Amarillo, Tex.	4,800	UN/UOP	onstream	preparation of catalytic reformer feed
Casper, Wyo.	4,800	UN/UOP	onstream	preparation of catalytic reformer feed
El Paso, Tex.	3,300	UN/UOP	onstream	preparation of catalytic reformer feed
Lawrenceville, Ill.	13,500	UN/UOP	onstream	preparation of catalytic reformer feed
Lockport, Ill.	11,000	UN/UOP	onstream	preparation of catalytic reformer feed
Lockport, Ill.	4,800	UN/UOP	onstream	preparation of catalytic reformer feed
Port Arthur, Tex.	20,000	UN/UOP	onstream	preparation of catalytic reformer feed
Port Arthur, Tex.	20,000	UN/UOP	onstream	preparation of catalytic reformer feed
West Tulsa, Okla.	9,000	UN/UOP	onstream	preparation of catalytic reformer feed
Westville, N.J.	12,000	UN/UOP	onstream	preparation of catalytic reformer feed
Tidewater Oil Co., Associated, Calif.	10,500	UN/UOP	onstream	improve cracked & SR naph. to meet specs., improve yield
Associated, Calif.	24,000	UN/UOP	onstream	improve various streams to meet prod. specs., improve yields
Delaware City, Del.	30,000*	UN/UOP	late '56	*capacity not confirmed by company
U Union Oil Co. of Calif., Rodeo, Calif.	15,750	UN/UN	onstream	desulf & denitrif SR & cracked gaso. for Platformer
Cut Bank, Mont.	900	UN/UN	onstream	desulf 450 b/d each of stove oil, diesel oil mixture
United Refining Co., Warren, Pa.	750	UN/UN	onstream	desulf & olefin sat. vis. gaso. to cat. reformer & hvy. dists.
V Vickers Petroleum Co., Inc.				
Potwin, Kans.	2,500	HD/SI	planned	preparation of naphthas for Ultraformer
W Western States Refining Co.,				
North Salt Lake, Utah	1,000	Houdry	planned	desulf naph. (up to 35% thermal) to Houdriformer
Wilshire Oil Co of Calif.,				
Norwalk, Calif.	10,000	UN/UOP	early '57	desulf SR & therm. cracked naph. for cat. reformer

CANADA

Canadian Petrofina, Ltd.,				
Pointe-aux-Trembles, Que.	3,000	ST/Sh	onstream	desulf (blocked oper.) stove oil, light atm. gas oil & light cat. cycle oil
Pointe-aux-Trembles, Que.	3,600	HD/SI	onstream	desulf of hvy. straightrun naphtha for cat. reformer
Husky Oil & Refining Ltd.,				
Moose Jaw, Alta.	1,000	DF/HO	onstream	desulf diesel oils
Imperial Oil Ltd., Edmonton, Alta.	2,000	HF/ERE	onstream	color & stability improvement of dewaxed lube stocks
Halifax, N.S.	6,300	HF/ERE	bldg	desulf of light virgin naphtha for Powerformer feed
IOCO, B.C.	5,000	HF/ERE	late '57	desulf of light virgin naphtha for Powerformer feed
Montreal, Que.	8,000	HF/ERE	early '57	desulf of light virgin naphtha for Powerformer feed
Sarnia, Ont.	540	HF/ERE	onstream	conv. from lube-wax unit to color & odor improv. of recrystallized waxes
Sarnia, Ont.	13,500	HF/ERE	onstream	desulf of light virgin naphtha for Powerformer feed
Sarnia, Ont.	4,000	HF/ERE	onstream	improve color & stability of dewaxed lube stocks
McColl-Frontenac Oil Co. Ltd.,				
Montreal East, Que.	10,000	PRIVATE	mid '57	desulf and storage stab. of No. 1 burner oil, diesel & light cycle gas oil
Montreal East, Que.	12,000	UN/UOP	onstream	desulf, denitrif & contaminant removal of 200/400°F SR for cat. reformer feed
Shell Oil Co. of Canada Ltd.,				
Montreal East, Que.	7,500	ST/Sh	onstream	desulf of M.E. flashed distillate
Vancouver, B. C.	3,800	UN/UOP	onstream	desulf, denitrif & olef. sat. naph. for Platformer

(2) *Hydrobon*

Starting below is a description of the characteristics and performances of commercially available hydrogen processes, as reported by the developing companies.

V-P Hydrodesulfurization

Shell Development Co.

Catalytic process using hydrogen for desulfurization and olefin saturation. Feedstocks are from straightrun naphthas to streams boiling up to about 500°F (usually considered practical in this vapor-phase process). Successful commercial applications include treating catalytically cracked naphthas for aviation and motor gasolines, light straightrun distillates to give light distillate fuels and mineral spirits, thermally cracked naphthas for motor gasolines.

Olefins can be saturated without hydrogenating the aromatics in the feed, or the process can be used for selective desulfurization of cracked naphtha (minimizing olefin saturation) for motor gasoline.

Catalyst is tungsten-nickel-sulfide, costing about $5.00/lb. Regeneration is *in situ*, using a mixture of steam and air followed by sulfiding with hydrogen sulfide. Original catalyst activity is completely restored. There is no limit to the number of times the catalyst can be regenerated. Ultimate life of the catalyst is limited only by disintegration of the catalyst pellets. Experience indicates an ultimate catalyst life of 600 barrels of cracked naphtha processed per pound of catalyst.

Operating conditions are typically 450-700°F, 500-750 psig, hydrogen rate about 6000 SCF/bbl of feed, and design space velocities of 5-15 v/hr/v (with higher possible).

First unit of the Shell Vapor Phase Hydrodesulfurization process went onstream March 1944 at the Shell Oil Co. refinery, Dominguez, Calif., with a capacity of 11,150 b/sd. Process licenses are available from Shell Development Co., Licensing Div., New York, N.Y.

Capital & Operating Costs —Catalytically Cracked Naphtha

($2,000,000 plant cost,[1] 10,000 b/sd, 93% onstream time)	*¢/bbl*
Utilities[2]	3.2
Chemicals and catalyst[2]	1.1
Hydrogen[3]	0.6
Labor (including benefits), 2 men	1.7
Maintenance (labor + matl), 4% of capital/yr	2.4
Overhead (taxes, insur., lab., + other) 7% of capital/yr	4.1
Total operating costs, ¢/bbl.	13.1[3]

(1) No off-site facilities and no product refractionation. (2) West Coast costs. (3) Hydrogen at fuel value. Add 0.4¢/bbl for thermally cracked naphtha feedstock.

Typical Applications of Vapor-Phase Hydrodesulfurization

Crude source	*Los Angeles Basin*		*Los Angeles Basin*				*West Texas*	
Feedstock cut	Cat Cracked Naph.		Cat Cracked Naph.		Therm Cracked Naph.		Light SR Intermediates	
Product	*Aviation Base Stock*		*Motor Gasoline*		*Motor Gasoline*		*Mineral Spirits, Kerosine*	
Hydrogen used, SCF/bbl	500		110-175		200-250		65	
Period before regen., months	3-4		2-3		2-3		10	
Properties, feed & products	*Charge*	*Product*	*Charge*	*Product*	*Charge*	*Product*	*Charge*	*Product*
Liquid yields, vol%	—	102	—	101	—	101	—	100
Total sulfur, wt%	0.28	0.003	0.50	0.20	1.15	0.40	0.45	0.10
Mercaptan sulfur, wt%	—	—	0.002	0.003	0.02	0.006	0.07	0.001
Bromine No., grams/100 gm	72	9	45	33	71	48	—	—
Maleic Anhydride value, mg/gm	30	0.1	20	1.2	28	1.0	—	—
Aromatics, wt%	33	33	41	41	11	11	—	—
ASTM gum, mg/100 ml	—	1	3	1	—	1	—	—
Copper dish gum, mg/100 ml	—	2	560	27	240	18	—	—
Induction period, hrs	—	—	—	24+	—	24+	—	—
Blending octane nos., ASTM								
D614 aviation (+4.6 ml TEL)	76	96	—	—	—	—	—	—
D909 supercharge (")	—	125	—	—	—	—	—	—
							Mineral Spirits	*Prime White*
ASTM distillation, °F								
IBP	152	141	286	283	228	221	320	315	380
50%	232	227	348	348	300	296	410	341	429
Dry point	297	298	—	—	—	—	—	—	—
EP	—	—	427	431	416	417	515	383	530

Trickle Hydrodesulfurization

Shell Development Co.

Catalytic process using hydrogen to remove sulfur from middle distillates, such as straightrun and catalytically cracked gas oils, and higher boiling distillates. Sulfur removal of 85-90% is obtained, and a small fraction of high octane gasoline is produced from the sulfur compounds.

Catalyst type is cobalt and molybdenum on alumina. Commercially available Co-Mo catalysts are adequate for this process. The catalyst costs $1.00-1.50/lb. and is supplied by catalyst manufacturers, both in Europe and the U. S. Regeneration is *in situ* with a mixture of steam and air (about 1-2% oxygen in mixture). Hot spot temperature during regeneration, as it travels through the catalyst bed, is controlled to 1100°F or lower. Regeneration time depends on the amount of carbon deposited. Several regenerations are possible, restoring original catalyst activity. Ultimate life of the catalyst is not known.

Operating conditions are 750-850 psia and 680-730°F for deep desulfurization (80-90% removal of sulfur) in middle distillates, with a typical space velocity of 2-6 v/hr/v and a recycle gas circulation rate of 250-1000 SCF/bbl.

Diluents in the hydrogen stream may reach up to 25 mol% (such as light hydrocarbon gases or nitrogen). If the hydrogen stream is more dilute than this, it must be concentrated before use. Normal H_2S buildup in recycle gas has little or no effect on desulfurization.

First Shell "Trickle" Hydrodesulfurization unit built went onstream April, 1955, at the Shell Refining & Marketing Co., Ltd., Stanlow, England, with a capacity of 7,000 b/sd. Two units are now operating (capacity 10,000 b/d) and five more are under construction (capacity 50,200 b/sd). Process licenses are available from the Shell Development Co., Licensing Div., N.Y., N.Y.

Shell Hydrodesulfurization Economics —10,000 b/sd Plant

(Major Contractor's Estimate—Gulf Coast, USA)

Charge Stock	Middle East Straightrun Gas Oil	Middle East Lt. Cat Cracked Cycle Oil
Boiling range, °F (ASTM)	496/666	446/650
Sulfur content, wt%	1.3	2.9
Sulfur removal, %	85	85
Investment[1]	930,000	1,300,000
Operating cost, ¢/bbl intake[2]	11.9	16.3
Hydrogen [3]	0.5	1.3
Catalyst	1.9	3.5
Utilities	1.7	2.5
Operating labor	2.4	2.4
Maintenance[4]	1.1	1.6
Supv. & refinery overhead[5]	3.8	4.2
Taxes & insurance [6]	0.5	0.8
Liquid Products, gal/bbl intake		
Diesel fuel component	42	38
Hvy gasoline component	—	4.5
Hydrogen sulfide, SCF/bbl intake	40	95

(1) Inside plot, including first catalyst charge, excluding process and engineering design. (2) Excluding depreciation and interest. (3) At fuel value of 10¢/MMBtu. (4) 4% of capital/yr. (5) 80% of operating labor plus maintenance. (6) 2% of capital/yr.

Typical Applications of Shell Hydrodesulfurization (Trickle Process)

	Middle East Light Catalytically Cracked Cycle Oil				Middle East Cycle and Gas Oil Mixture [3]				Middle East Light Catalytically Cracked Gas Oil[5]				
		Product Properties				Product Properties				Product Properties			
	Charge	Below 430°F	430-500°F	Above 500°F	Charge	Below 430°F	430-500°F	Above 500°F	Charge	Below 430°F	430-500°F	Above 430°F	Above 500°
ASTM dist., °F													
IBP	400	311	403	484	426	291	392	500	446	270	437	475	532
10%	480	318	419	509	—	327	432	534	—	—	—	—	—
50%	534	328	446	552	—	340	446	581	—	—	—	—	—
90%	612	344	467	617	642	356	478	647	—	—	—	—	—
EP	648	378	511	653	682	403	509	674	650	417	480	650	650
Sulfur, wt%	2.48	<0.01	0.06	0.35	2.28	0.01	0.04	0.31	2.90	0.01	0.02	0.34	0.43
Gravity, °API	—	—	—	—	—	—	—	—	21.3	33.8	25.4	26.1	25.5
Octane numbers													
ASTM, no TEL	—	—	—	—	—	—	—	—	—	90	77	—	—
CFRR, no TEL	—	i-C_5+[1]	—	—	—	100	—	—	—	100+	88	—	—
CFRR + 1.5 ml TEL/gal	—	i-C_5+[2]	—	—	—	i-C_5+[4]	—	—	—	—	—	—	—
Color, Union	1½+	—	—	1½—	—	—	—	1+	—	—	—	—	—
Pour Point, °F	—	—	—	—	—	—	—	—	14	—	—	19	25
Viscosity, Redwood I sec, 100°F	—	—	30	35	—	—	30	—	—	—	—	—	—
Diesel Index	21	—	—	31	32	—	—	43	19.5	—	—	27.1	29.9
Aromatics, vol%	60	82	71	57	—	72	66	—	—	—	—	—	—
Yields, vol% of charge	—	5	25	72	—	5	21.5	76	—	10.7	21.3	90.4	69.1

(1) With 0.16 ml TEL/gal. (2) With 0.55 ml TEL/gal. (3) 70/30 mixture of light cat. cracked cycle oil and straightrun heavy gas oil. (4) with 0.3 ml TEL/gal. (5) Operating conditions: 710°F, 750 psig, recycle-gas rate of 1350 SCF/bbl charge, space velocity 3.0 v/hr/v.

Diolefin Hydrogenation

Shell Development Co.

Catalytic process using hydrogen to saturate diolefins into mono-olefins in alkylation feedstocks. Feedstocks treated are C_4 and C_5 fractions with diolefin contents too high for suitable isoparaffin alkylation. Little, if any, olefin saturation is noticed during the hydrogenation of diolefins into additional olefins.

Catalyst is NiS on alumina, which can be supplied by Shell or catalyst manufacturers. It contains 13% NiS. Regeneration is *in situ* by burning carbon and polymers off of the catalyst with a diluted air stream at 750°F, followed by sulfiding with hydrogen sulfide at 750°F. Catalyst price is $1.00-1.50/lb, depending upon the quantity bought.

Operating conditions are 480-660°F, 15-150 psig, 1:1 mol ratio of hydrogen to feed, 2-8 v/hr/v space velocity. Dilute hydrogen streams from catalytic reformers can be used, providing that the hydrogen partial pressure is maintained in a suitable range. Impurities in the gas stream, such as carbon monoxide, carbon dioxide, water and nitrogen compounds, should not give significant problems.

Investment and operating costs are functions of feed composition, therefore it is difficult to give general figures. Qualitatively, it can be said that when the process is applied to treatment of alkylation feedstocks, improved acid life and conversion of butadiene to butylene give the selective hydrogenation process an attractive payout.

The first unit onstream was in 1949 for the Shell Refining and Marketing Co. Ltd., Stanlow, England. This Stanlow unit processes about 400 b/d of C_4 feed containing 20-25 mol% butadiene, with the treated C_4 fraction not intended to be used for alkylation feedstock purposes.

Process licenses are available from the Shell Development Co., Licensing Div., New York, N.Y.

Selective Hydrogenation of Diolefins into Mono-Olefins

A—Pentadiene Hydrogenation @ 480°F,[1] LHSV = 1, H_2/C_5H_8 ratio = 5/1-8/1. Feed Composition: 70 mol% pentadienes, 26 mol% pentenes, 4 mol% pentanes.

Hours of Operation	Lb Feed/lb Catalyst	Reaction Hot Spot, % of Catalyst Bed	Pressure psig	Analysis of Hydrogenated Product Mol% C_5H_8	Mol% C_5H_{10}	Wt% Heavy Ends[2]
0 (feed)	—	—	—	70	26	3
34	22	20	50	1.8	94.0	5.0
60	39	30- 50	30	2.1	95.6	5.9
108	71	50- 70	80	1.2	95.8	5.4
222	145	70-100	80	1.8	95.4	5.0
264	173	—	80	2.7	94.3	4.8
330	216	—	100	0.3	91.5	6.8

B—Butadiene Hydrogenation @ 480°F,[3] LHSV = 2, H_2/C_4H_6 ratio = 6/1. Feed Composition: 10.9 mol% butadiene, 15.8 mol% 2-methylpropene, 27.5 mol% n-butenes, 46.8 mol% butanes.

				Mol% C_4H_6	Mol% C_4H_8	Wt% Polymer
0 (feed)	—	—	50	10.9	43.3	—
87	54.8	—	50	0.04	54.7	<0.1
140	125.4	—	50	0.06	—	—
311	357.1	—	50	0.16	—	—
371[4]	440.1	—	50	0.3	54.6	<0.8
400[5]	490.0	—	50	0.7	54.8	0.3

C—Butadiene Hydrogenation @ 480°F,[6] LHSV = 2, H_2/C_4H_6 ratio = 4/1. Feed Composition: 23 mol% butadiene, 17 mol% 2-methylpropene, 55.5 mol% n-butenes, 4.5 mol% butanes.

				Mol% C_4H_6	Mol% C_4H_8	Wt% Polymer[7]
0 (feed)	—	—	150	23.0	72.6	0.3
97	112	10	150	0.13	96.0	0.5
189	219	10-20	150	0.06	96.1	0.3
278	321	20	150	0.02	96.2	0.3
368	425	20	150	0.04	95.9	0.4
482	552	20	150	0.07	95.6	0.6
591	673	20-30	150	0.10	95.4	0.6
710	805	20-30	150	0.08	94.3	1.6
798	912	35	150	0.09	97.0	0.7
922	1064	35	150	0.10	95.0	0.6
955	1105	25-35	150	—	—	—

(1) Hot spot averaged 57-75°F higher. (2) Heavy ends >113°F. (3) Hot spot 21°F higher. (4) Sample taken during operation at 100 psig and LHSV = 5.3. (5) Sample taken after period of operation at 570° F, catalyst may have been partially inactivated. (6) Hot spot 54-90°F higher. (7) Material boiling above 59°F; some was in the starting feed.

Hydrofining

Esso Research & Engineering Co.

Catalytic process using hydrogen for desulfurization, olefin saturation, and quality improvement of refinery streams. Feedstocks are refinery gases through waxes.

Catalyst generally used is alumina supported metal oxides, including cobalt and molybdenum, supplied by several catalyst manufacturers. Regeneration is *in situ* using air (diluted by either steam or recycle flue gas and heated to 650-750°F) to completely burn off carbon, sulfur, polymer and nitrogen poisons. Regeneration time varies from 1-4 days. Ultimate catalyst life is not established, but is probably 2-plus years. The catalyst comes as ⅛-in. or 3/16-in. extruded or prilled pieces, with a bulk density of 45-50 lb/cu ft.

Operating conditions are typically 50-800 psig, 500-750°F, 0.5-16 v/hr/v, and gas treat rates as low as 200 SCF/bbl.

Hydrogen diluents in most Hydrofining units are hydrocarbons, CO, CO_2, nitrogen and H_2S. Most diluents only reduce hydrogen partial pressure, but carbon monoxide reduces cobalt molybdate catalyst activity, and is removed as far as possible. The hydrogen concentration is usually kept above 50%.

The first Hydrofiner was a 2500 b/sd unit for treating waxes at Esso Standard Oil Co.'s Bayonne, N.J. refinery, onstream 1950. Process licenses are available from Esso Research & Engineering Co., New York City.

Typical Investment and Operating Costs

(Reactor @ 150 psig, 675°F, 1.2 v/hr/v, & H_2 @ 750 SCF/bbl)

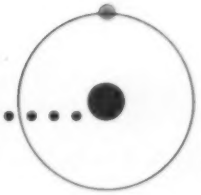
	Case 1		Case 2		Case 3	
Feed rate, b/sd	3,000		10,000		20 000	
Erected cost(1) **MM$**	0.325		0.65		1.0	
Operating costs(2)	**Amt.**	**$/cd**	**Amt.**	**$/cd**	**Amt.**	**$/cd**
Labor	—	254	—	291	—	331
Materials	—	31	—	49	—	68
Catalyst	—	61	—	200	—	400
Cooling H_2O, M gal	350	4	1,170	12	2,340	24
Stm. (150 lb), M lb	36	11	120	36	240	72
Power kwh	575	4	2,300	15	4,600	30
Fuel, MM Btu	210	38	700	126	1,400	252
Total	—	**403**	—	**729**	—	**1,177**

(1) Rough sales-type figures for onsite costs, Gulf Coast basis. (2) Not included are taxes, deprec., refinery burden, or expense items. Covers only onsite operating costs.

Typical Examples of Hydrofining for Quality Improvement

Feed Stream	*Effect of Hydrofining Various Stocks*			*Purpose of Hydrofining*
	Property	*Feed*	*Product*	
Refinery gas				Remove sulfur & sat. olefins for use as hydrogen plant feed
Virgin naphtha	Sulfur, wt.%	0.12	0.001	Remove sulfur for Powerformer feed
Cracked naphtha	Sulfur, wt.%	0.24	0.07	Improve stability & engine cleanliness; desulfurize product
	Bromine No.	23	17	
	GM Gum	3	0.5	
	ASTM Breakdown, mins.			
Kerosine	Sulfur, wt.%	0.55	0.10	Improve odor, wick char & color; reduce color & sweeten product
	Wick char	65	23	
	Saybolt colorhold	+3	+23	
	Copper No.	68	<1	
	Doctor test	DNP	Pass	
	Odor	Poor	Good	
Solvents	Sulfur, ppm	144	<3	Improve odor & reduce sulfur
	Odor	Fail	Pass	
Heating oil	Carbon res., 10%	0.09	0.04	Reduce carbon residue level & blending value; improve stability
	Blending value	0.45	0.04	
	Color, TR	13	17	
Diesel fuel	Sulfur, wt.%	0.92	0.2	Desulfurize, reduce neutralization number, increase diesel index, & upgrade cracked stock from fuel oil to diesel oil
	Copper No.	92	0.2	
Gas Oils for cat. feed	Sulfur, wt.%	1.8	0.4	Desulfurize & improve catalytic cracker gasoline yields
	Con Carbon, wt.%	0.3	0.1	
	Nitrogen, wt.%	0.04	0.02	
Lube oils	Color, TR	6 ⅜	21 ¼	Improve stability, colorhold, Con Carbon & stability; reduce sulfur
	Colorhold	4 ¼	19 ¾	
	Pour, °F	20	25	
	Con Carbon, wt.%	0.04	0.02	
	Sulfur, wt.%	0.19	0.04	
	Indiana life, hrs.	29	60	
Wax	Color	13TR	—12 Sayb.	Improve color, colorhold, odor, odor stability & reduce USP acid
	USP Acid reduct., %		30	
	Sulfur reduct., %		50	

Unifining



Universal Oil Products Co. & Union Oil Co. of Calif.

Catalytic process using hydrogen for desulfurization, denitrification, deoxygenation, olefin saturation and metal contaminants removal. Feedstocks can be distillates of any boiling range, including light and heavy naphthas, kerosines, diesel fuels, stove oils, and vis-breaker distillates, cat cracker cycle oil, heavy vacuum gas oils, lube oils, and aromatic distillates.

Catalyst-type is cobalt-molybdenum-alumina. The Union catalyst also contains silica. Universal Oil Products Co. licenses use "Hydrobon" catalyst made by UOP's Universal Polychem Mfg. Div. Union licenses use catalyst made by Harshaw Chemical Co., designated "Harshaw Co-Mo-0401-T." Regeneration is *in situ*, using steam and air. Ultimate catalyst life and total possible regenerations are not yet known.

Operating conditions: generally 500-800°F, 300-800 psi (higher pressures possible). Pressure and temperature depend upon feedstock and desired results.

First Unifiner (Union license) was 750 b/d (now 2500 b/d) unit for United Refining Co., Warren, Pa., onstream 1954. First Hydrobon unit (UOP process name prior to joint licensing with Union) was 13,000 b/d unit for Standard Oil Co., of Ohio, Lima, Ohio. onstream 1954. Licensed units number more than 30 operating, with capacity of over 200,000 b/d and 24 under construction. Process licenses available from Universal Oil Products Co., Des Plaines, Ill., or Union Oil Co., of Calif., Wilmington, Calif.

Operating & Investment Costs

(5000 b/sd capacity: July 1956 figures)

	SR & cracked[1] naph. (210-500°F)	SR gas oil[2] (400-650°F)
Erected plant cost	$800,000[3]	$570,000[4]
Operating cost, ¢/bbl/yr[5]	16.1	10.6
Labor @ $2.75/hr	2.0	1.3
Utilities[4]	8.0	4.5
Catalyst	< 1.5	< 2.0
H_2 used @ 15¢/MMBtu	1.5	0.5
Maintenance	1.9	1.4
Insurance & property taxes	1.2	0.9

(1) Includes stabilizer and splitter for catalytic reformer feed and fuel oil. (2) For diesel fuel—includes H_2S stripper and booster compressor for once-through hydrogen. (3) Excludes royalty, depreciation, administration and overhead. (4) Fuel @ 20¢/MMBtu, power @ 1.0¢/kwh, steam @ 50¢/Mlb, water @ 2¢/Mgal. (5) $500,000 for 2500 b/sd unit, $1,250,000 for 10,000 b/sd unit. (6) $350,000 for 2500 b/sd unit, $900,000 for 10,000 b/sd unit. (7) For diesel fuel—includes H_2S stripper and booster compressor

Typical Applications of Unifining

	Sat. & Desulf. of Cat. Cycle Oil to Diesel Fuel		*Platformer Feed from 60% Condensate, 40% SR Gaso.*		*Part of Platformer Feed from 1/3 Visbreaker, 2/3 SR Gaso.*		*Part of Platformer Feed & Stove Oil from Naphtha-Stove Oil Cut*			*Arabian SR Gas Oil to Diesel Fuel*	
	Charge	**Product**	**Charge**	**Product**	**Charge**	**Product**	**Charge**	**Stove Oil**	**Plat. Feed**	**Charge**	**Product**
Gravity, °API	29.6	33.0	56.4	56.5	62.8	64.4	50.4	41.2	53.3	38.7	39.8
ASTM dist., °F											
IBP	376	380	163	160	100	101	160	399	178	370	393
10%	446	434	196	194	160	160	236	402	234	430	442
50%	494	482	249	248	241	242	298	410	288	496	496
90%	572	552	—	—	325	328	372	431	348	601	596
EP	630	618	398	398	399	394	425	506	390	663	654
Paraffins, vol%	—	—	57.0	57.3	50.1	61.1	—	—	—	—	—
Olefins, vol%	—	—	0.4	trace	16.2	0.3	—	—	—	—	—
Naphthenes, vol%	—	—	33.5	33.6	27.5	34.3	—	—	—	—	—
Aromatics, vol%	—	—	9.1	9.1	6.2	4.3	—	—	—	—	—
Bromine No.	11.6	2.96	1.0	0.3	33.3	0.5	28.0	0.9	0.7	—	—
Total sulfur, wt%	1.04	0.11	0.14	< 0.002	0.137	0.000	0.660[3]	0.0029[3]	0.0025[3]	0.9	0.04
Basic nitrogen, ppm	—	—	—	—	2	< 1	49	2.4	0.3	—	—
Total nitrogen, ppm	—	—	< 1	< 0.5	6	2	62	6.4	0.5	—	—
Arsenic, ppb	—	—	< 1	< 1	192	< 1	55	< 1	< 1	—	—
ASTM gum, mg	—	—	—	—	10.1	0.6	—	—	—	—	—
Induc. period, min.	—	—	—	—	250	> 1000	—	—	—	—	—
Research octane clear	—	—	48.0	—	60.7	52.0	56.6	—	49.2	—	—
Research + 3 ml TEL	—	—	—	—	74.9	73.3	68.6	—	73.1	—	—
Yield, vol% charge	—	98.4	—	100.0	—	100+	—	100.0[6]	100.0[6]	—	[5]
Pure H_2 used, SCF/bbl	—	334	—	30[1]	—	200[1]	—	264	264	—	140[1]
Color, Saybolt	—	—	—	—	—	—	−16	15	30+	—	—
Color, NPA	1.5	1.0	—	—	—	—	—	—	—	—	—
Aniline Pt., °F	126	128	—	—	—	—	—	—	—	—	—
Flash Pt. (P-M), °F	115	167	—	—	—	—	—	—	—	158	175
Diesel Index	37.8	42.8	—	—	—	—	—	—	—	—	—
Cetane No.	41.0	44.0	—	—	—	—	—	—	—	—	—
Pour Point, °F	−8	−10	—	—	—	—	—	—	—	—	—

(1) Estimated. (2) Also desulfurize, denitrify, deoxygenate, saturate, remove metal contaminants. (3) Charge: 0.072% mercaptan sulfur, 0.014% H_2S. Stove oil: 0.001% RSH, no H_2S. Naphtha: no RSH, no H_2S. (4) Total liquid products recovery. (5) Product reported after stripping.

Hydrogen Treating

Sinclair Refining Co.

Catalytic process using hydrogen for primary purposes of desulfurization, denitrification, deoxygenation, and metal contaminants removal, applicable to all refinery streams. All types of sulfur are converted to hydrogen sulfide. Other impurities, such as nitrogen and oxygen, are removed, or substantially reduced.

Catalyst-type is cobalt-molybdenum on an alumina base (see section on "Catalysts You Can Buy" for details on catalyst properties). This catalyst, Nalco Type RD-154, is made solely by National Aluminate Corp. according to composition and physical specifications of the Sinclair Research Laboratories.

Regeneration is *in situ*, using a controlled quantity of air mixed with superheated steam for combustion of carbonaceous deposits on the catalyst. Catalyst life, activity, and selectivity are returned to virgin quality. Regeneration requires 24-72 hours, depending upon the quantity of carbonaceous material on the catalyst.

Ultimate catalyst life is not yet known, but bench scale tests indicate that at least 10 regenerations are feasible. It is estimated that an ultimate life of at least 100 bbl feed per lb of catalyst will be obtained on distillate stocks, and at least 250 bbl/lb on naphtha stocks. No poisoning difficulties have been observed in processing a wide variety of refinery streams.

Operating conditions are typically 580-780°F (depending upon the stock and degree of desulfurization desired), 200-800 psi, hydrogen recycle rates of 500-5000 SCF/bbl of feed, and space velocities from 1-8, depending upon the stock processed. During an operating cycle, the temperature is usually raised to compensate for catalyst activity loss. While most Sinclair units are designed to operate around 500 psig, stocks with high nitrogen contents respond better to higher pressures of about 700 psig. Space velocities may be as low as 2 for high-sulfur cycle oils, or as high as 8 for straightrun naphthas. Higher boiling stocks have complex sulfur compounds needing low space velocities, but the less complex sulfur compounds in naphthas are easily reduced at much higher velocities.

Maximum dilutents in the hydrogen stream have not been thoroughly investigated. The normal catalytic reformer off-gas, containing at least 65 mol% hydrogen, is suitable. Lower hydrogen contents can be used with suitable variations in processing variables.

Investment costs for a battery limits plant are $100-200/bbl feed, depending upon size, location, and type of feedstock.

First unit using Nalco RD-154 Desulfurization Catalyst was for Sinclair Refining Co. at their Marcus Hook, Pa. refinery. This unit, designed to desulfurize 10,000 b/d of fluid cycle oil, was placed onstream December 30, 1955. Total units onstream number four (two for Sinclair, two for Richfield Oil Co.) with a total capacity of 57,000 b/d, and sizes ranging from 6,000-24,000 b/d.

Units planned number two (both for Sinclair), each with a capacity of 12,000 b/d. There are no licensing arrangements for the Sinclair process, but the Nalco RD-154 catalyst can be purchased from National Aluminate Corp., Chicago, Ill.

Typical Operating Expenses —10,000 b/d Plant

(Treating Fluid Light Cycle Oil)

	¢/bbl
Labor (including labor benefits)	2.0
Maintenance (labor & material)	2.3
Utilities	3.5
Chemicals and catalyst	1.0
Hydrogen (fuel value)	1.0
Taxes & Insurance	1.2
Total (excluding refinery overhead)	11.0

Typical Utility Requirements —10,000 b/d Plant

(Treating Fluid Light Cycle Oil)

Steam, 125 lb, lb/hr	25,000
Power, kw	200
Fuel, MMBtu/hr	10
Cooling water, ($\Delta T = 25°F$) gpm	3,000

Typical Applications of Sinclair's Hydrogen Treating Process

(Using Nalco Type RD-154 Desulfurization Catalyst)

Processing conditions	Straightrun Naphtha	Blend of Virgin and Vis-broken Naphthas	Virgin Heating Oil	Fluid Cycle Oil
Temperature, °F	700	700	700	700
Pressure, psig	250	700	500	500
Weight/hr, space velocity	6	5	3	2
Hydrogen recycle, SCF/bbl	800	3500	2000	3000
Hydrogen consumption, SCF/bbl	10	170	110	180

Inspection tests	Charge	Product	Charge	Product	Charge	Product	Charge	Product
Gravity, °API	55.0	55.3	50.0	51.0	37.4	38.8	25.9	29.2
Sulfur, wt%	0.062	0.001	0.31	0.001	0.80	0.05	1.80	0.08
Bromine, No.	1.2	0.2	15.9	0.1	7.0	1.0	23.8	8.1
Nitrogen, wt%	0.001	0.000	0.006	0.000	0.015	0.007	0.030	0.015
Color, Saybolt	30+	30+	—10	30+	—	—	—	—
Color, NPA	—	—	—	—	1½	1½	1½	2
Arsenic, ppb	4	4	10	4	—	—	—	—
Lead, ppb	—	—	100	3	—	—	—	—

Hydrodesulfurization

Standard Oil Co. of Indiana

Catalytic process using hydrogen for primary purposes of desulfurization and olefin saturation. Feedstocks range from naphthas through lube stocks. Other applications are selective desulfurization of cracked naphthas to reduce sulfur and improve stability while maintaining octane quality; upgrading cracked components into suitable jet fuel blending components; hydrogenating, desulfurizing and denitrogenating virgin and cracked gas oils and cycle oils to improve catalytic cracking performance; hydrofinishing lube stocks to eliminate acid treating and clay treating.

Catalyst type is cobalt-molybdenum on alumina, made to Standard Oil Co. (Ind.) specifications. Regeneration is *in situ*, using steam-diluted air to burn carbonaceous deposits. Unless there are metal contaminants in the feedstock (usually only in crude), regeneration restores original activity and selectivity. Cycle lengths after regeneration are usually the same as with fresh catalyst. Regeneration time is typically 10-20 hours. Available air or allowable pressure drop through the catalyst bed are the only limits. At least 50-100 regenerations should be possible before replacing the catalyst. Ultimate catalyst life, where metal contaminants are not a problem, and may be 2-5 years.

Operating conditions are typically 600-800°F, 200-1500 psig, space velocity of 1-20 v/hr/v, diluent gas addition rate of 500-4000 SCF/bbl, diluent gas H_2 concentration of 65-90 vol%. Hydrogen concentration of at least 70 mol% is desirable in the hydrogen stream. Lower concentrations can be used for mild processing, or if more frequent regeneration is acceptable. Major impurities in the gas should be hydrocarbons. Both reformer and manufactured hydrogen have been used.

Investment costs are said to be competitive.

First unit for Standard Oil Co. (Ind.) Hydrodesulfurization process was at the Pine Bend refinery of Great Northern Oil Co. at St. Paul, Minn. Licensed units in operation number 10, totaling over 120,000 b/sd capacity. New and expanded units will add another 126,000 b/sd. Process licenses are available from the Standard Oil Co. of Ind., Chicago, Ill.

Typical Operating Requirements

(8500 b/d cycle oil hydrogenation)

Direct charges	
Labor, men	2-3
Maintenance, % of plant investment/yr	3-4
Catalyst life, bbl/lb	250
Hydrogen, SCF/bbl	170
Utilities	
Cooling water, gpm (90-120°F)	1860
Steam, lb/hr, 100 psig, 400°F TT (exclusive of drivers)	2660
Electricity, kwh (exclusive of drivers)	25
Pumps and compressors, THP	220
Fuel, MMBtu/hr	21
Indirect charges	
Royalty, paid-up, $/b/d	38

Typical Hydrodesulfurization Applications

	Pretreat Reformer Feed of 60% Virgin—40% Coker Naphtha[1]		*Make No. 1 Fuel Oil from Marginal Quality Stocks*[2]		*Upgrade Diesel Fuel Component of Catalytic & Coker Oil*[3]	
	Charge	**Product**	**Charge**	**Product**	**Charge**	**Product**
Gravity, °API	56	57	41	42	31	33
IBP	175	170	346	349	368	376
10%	209	207	386	389	426	426
50%	252	251	450	446	494	489
90%	323	325	518	515	560	565
Max.	375	380	552	550	626	631
Olefins, vol%	15	1	—	—	—	—
Bromine No.	29	0.5	—	—	—	—
Sulfur, wt %	0.32	0.0030	0.60	0.06	1.10	0.09
Nitrogen, wt%	0.0031	0.0006	—	—	—	—
Yield, vol% charge	—	100	—	98.0	—	95.5
400°F EP gasoline	—	—	—	2.8	—	6.1
Sediment[4]	—	—	—	—	1.9	0.8
Color, Saybolt	—	—	+25	+27	—	—
Color stabil., Saybolt	—	—	poor	+13	—	—
Gum, D381	—	—	—	—	83	20
Floc gum	—	—	—	—	14.4	5.3
Worrall Burner						
Side deposits	—	—	3	0.6	—	—
Bottom deposits	—	—	13	11	—	—
Odor	—	—	poor	good	—	—
Doctor	—	—	sour	sweet	—	—
Cetane No.	—	—	—	—	36.7	40.8

(1) Remove sulfur, nitrogen, saturate olefins. (2) Remove sulfur, reduce deposits, improve odor and color stability of W. Texas virgin heater oil. (3) Reduce sulfur, improve stability and cetane number of feed (84% cat. cycle oil; 16% coker gas oil). (4) Accelerated aging, 20 hr @ 200°F.

Gulf HDS Process

Gulf Research & Development Co.

Catalytic process using hydrogen to convert heavy residuals to lower boiling distillates—also desulfurizes charge stock. Feedstock of whole crude best suited for 20,000-25,000 b/cd new refineries. Economics favor residuals (with or without catalytic cycle stock blend) for existing or large refineries.

Catalyst is a supported metallic compound, costing $1.00-1.50/lb (2.8-6.8¢/bbl throughput). Regeneration is *in situ*, using air diluted with steam or flue gas to remove sulfur and coke. Gases are preheated to 750°F, regeneration temperature held to 1200°F maximum, continued until catalyst bed drops to about 1050°F. Ultimate life of catalyst depends on attrition, is estimated at 2-plus years. Catalyst is usually ⅜-in. pellets on alumina base, bulk density 50-55 lb/cu ft.

Operating conditions are typically 750-850°F, 500-1000 psig, 0.5-2.0 v/hr/v, 65-90 vol% H_2 in recycle gas, 2500-5000 SCF/bbl recycle gas, 0.5-30 day regeneration cycle. Hydrogen diluents should not exceed 25 mol%, mostly hydrocarbons.

No commercial units onstream to date. Licensing agent for this Gulf Research & Development Co. process is M. W. Kellogg Co., New York City.

Chemicals, Utilities & Investment —20,000 b/cd Units

Charge stock	West Texas Crude	Kuwait Blend[1]
Location of unit	Gulf Coast	East Coast
Investment,[2] MM$	9.6[3]	15.4[4]
Chemicals used, ¢/bbl	3.5[5]	9.0[6]
Utilities, units/bbl		
Fuel gas,[7] bbl (FOE)[8]	0.08	0.13
Power, kwh	1.03	0.97
Cooling water, M gal	1.46	3.75
Boiler feedwater, M gal	0.01	0.02
Steam (650 lb), M lb	—	0.13
Steam (300 lb), M lb	0.09	0.18
Direct operating cost, ¢/bbl	25	75
Total operating cost,[9] ¢/bbl	50	110

(1) 71% vac. tower bottoms, 29% light cat. cycle oil. (2) No off-site facil. (3) Reaction & regen. sections, 62.5%; recovery, 6.8%; H_2 unit, 20.3%; chem. & cat. inventory, 5.1%; paid-up royalty, $25/bbl charge. (4) Reaction & regen. sections, 72.4%; recovery, 4.7%; H_2 unit, 16.2%; chem. & cat. inventory, 3.4%; paid-up royalty, $25/bbl charge. (5) HDS cat., 2.8¢; H_2 prod. cat., 0.2¢; MEA, 0.5¢. (6) HDS cat., 6.8¢; H_2 prod. cat., 0.6¢; MEA, 1.6¢. (7) Incl. process gas for H_2 manuf. (8) Fuel oil equiv. (9) Incl. 10% deprec. and fixed charges.

Yields, Utilities, Performance & Investments for Gulf HDS Process

	Desulfurization—Kuwait Residues						Desulfurization—Heavy Fractions			
Location	East Coast			East Coast			Mid-Continent		Great Lakes	
Charge stock	Vacuum Bottoms[1]			Blend[2]			Blend	Vac. Tar	Blend	Red. Crude
Rate, b/sd	3740			5252			5700	3300	17900	15200
Rate, b/cd	—			—			5199	3015	16200	13800
Gravity, °API	5.8			10.7			13.5	10.0	17.3	17.0
Sulfur, wt.%	5.45			4.87			0.9	1.2	1.1	1.1
Carbon res., Conradson wt.%	19.8			15.2			8.7	13.0	5.3	6.0
Operating severity	High	Med.	Low	High	Med.	Low	—	—	—	—
H_2 consumption, SCF/bbl	1140	650	425	930	745	430	566	645	359	326
Product										
Coke, wt.%	6.4	2.4	0.6	3.3	2.2	0.3	1.5	1.5	1.6	1.4
Sulfur,[3] wt.%	5.1	3.8	2.5	4.7	3.4	2.2	—	—	—	—
Dry gas, wt.%	6.4	1.5	0.9	5.2	3.3	1.6	2.5	2.0	2.1	1.8
Deprop. liq., °API	33.2	20.8	15.2	32.8	25.2	19.0	—	—	—	—
Total C_4+, wt.%	82.7	92.2	95.8	87.2	91.9	94.9	—	—	—	—
Sulfur, wt.%	0.41	1.64	3.08	0.40	1.55	2.72	—	—	—	—
Carbon residue, wt.%	1.09	8.43	14.1	1.73	4.56	10.6	—	—	—	—
Butanes, vol.%	—	—	—	—	—	—	2.7	2.3	2.4	2.3
Pentanes, vol.%	—	—	—	—	—	—	1.4	1.2	1.2	1.1
C_5-400°F, vol.%	—	—	—	—	—	—	23	17	21	19
400-622°F, vol.%	—	—	—	—	—	—	34	31	30	31
622°F+, vol.%	—	—	—	—	—	—	43	54	45	47
Oct., clr. res., 8#RVP gaso	—	—	—	—	—	—	60	57	63	61
Cetane No., 400-622°F cut	—	—	—	—	—	—	41	41	40	39
Cooling water, gpm	5340	3500	3040	5970	4390	2688	4000	7000	18000	16000
Treated water, gpm	104	44	11	130	60	9	55	100	400	350
Boiler feedwater, gpm	100	76	68	136	97	73	75	100	250	200
Steam,[4] lb/hr	−23100	+6380	+19420	−20460	−1010	+21760	+7000	+15000	−23000	−14000
Fuel, MMBtu/hr.	121	94	81	169	114	78	100	70	300	200
Power, kw	220	170	165	245	190	185	200	150	670	570
HDS catalyst, lb/cd	410	158	106	427	240	97	345	210	1020	870
Men per shift	6	6	4	6	5	4	4	4	6	6
Investment, MM$										
React. & Regen. sections	7.5	4.4	3.1	8.0	5.1	2.9	2.6	1.9	6.2	5.0
Catalyst inventory	—	—	—	—	—	—	0.76	0.46	2.0	1.9

(1) Vac. tower bottoms, 17% of crude. (2) 71% bottoms, 29% cycle. (3) H_2S in off-gas plus sulfur in coke and combined with the catalyst. (4) Steam from process is (−); outside steam used is (+).

Diesulforming

Husky Oil Co.

Catalytic process using hydrogen primarily for desulfurization of petroleum streams, but also for removal of nitrogen and oxygen. Feedstocks successfully processed include distillates with 0.75% sulfur and 500°F EP, to 2.5% sulfur and 760°F EP. The process is also applicable to lighter stocks.

Catalyst is a molybdenum type that sells at about $1.00/lb. Regeneration is *in situ* by burning with a dilute air-in-steam mixture, and requires about 2-3 days. Indirect evidence indicates that regeneration removes all catalyst poisons. Ultimate catalyst life, and total possible regenerations, are not yet known. Catalyst in the original Diesulforming unit was installed in 1953, and is still very active. It has been regenerated three times, twice for reactor inspection (sulfided catalyst is very pyrophoric) and once because of poor catalyst activity. The catalyst is in grayish-blue pellets with a bulk density of 65 lb/cu ft. It is hard, resistant to abrasion, and has a high surface activity.

Operating conditions vary with the type of stock processed, but are typically 650-800°F, 450-550 psig, space velocity of 1-2 v/hr/v, and a minimum hydrogen recycle rate of 5000 SCF/bbl of feedstock.

Hydrogen diluents are C_1, C_2, C_3 and H_2S. There is no attempt to control hydrogen concentration in the recycle gas. The process will desulfurize 2%-sulfur gas oil with as little as 50% hydrogen in the recycle stream. However, desulfurization activity drops as the hydrogen concentration is lowered.

Total investment cost for a 1000 b/d Diesulforming unit is about $250/bbl of capacity.

First Diesulformer was for Husky Oil Co. at its Cody, Wyo. refinery, onstream August 12, 1953. This 1000 b/d unit is for desulfurization and general product improvement of straightrun distillates and gas oils. Process licenses are available from Husky Oil Co., Cody, Wyo.

Diesulforming for Sulfur Removal

	Medium Distillate[1]		*Light Distillate*[2]		*Light Diesel*		*Heavy Diesel*	
	Charge	**Product**	**Charge**	**Product**	**Charge**	**Product**	**Charge**	**Product**
Gravity, °API	30.2	33.2	39.2	40.6	35.9	37.9	32.3	35.0
Sulfur, wt%	2.2	0.35	1.02	0.105	1.32	0.21	1.77	0.37
ASTM dist., °F								
IBP	473	415	379	363	361	371	392	362
10%	516	512	408	383	422	424	464	451
50%	570	564	440	432	491	493	554	552
90%	624	617	495	488	601	597	619	611
EP	656	658	533	545	666	663	674	664
Flash, °F	220	205	154	147	155	160	165	160
Aniline Point, °F	142	152	136	143	142	148	145	153
Pour Point, °F	5	5	—50	—50	—20	—20	0	0
Dist. yield, vol%	—	98.4	—	96.2	—	97.3	—	98.6
Naphtha yield, vol%	—	1.7	—	4.0	—	2.7	—	1.5
Sulfur removal, %	—	84	—	90	—	84	—	79
Hydrogen consumed,[3] SCF/bbl	—	150	—	93	—	115	—	138
Odor	poor	good	poor	good	poor	good	poor	good
Doctor test	—	—	DNP	Pass	—	—	—	—
Cetane Number	48	52	45	47	47	50	48	51

(1) No. 1 burner fuel. (2) No. 2 burner fuel. (3) Hydrogen stream is 95 mol% H_2, remainder C_1, C_2 & C_3.

NEED A CATALYST?

Turn page for information on seven types of hydrogen processing catalysts that you can buy today

The Catalysts Available To You

The Girdler Co.

Manufacturer of G-35A and G-35B catalysts for desulfurization, dentitrification, deoxygenation and olefin saturation of C_3 fractions through 1000° F EP cylinder stocks, with residues being investigated. Catalyst properties are:

	G-35A	G-35B
CoO, %	1.8	3.5
MoO_3, %	10.2	10.0
Catalyst base	alumina	
Pellet size,* in.	3/16 x 3/16 cylinders	
Bulk density, lb/cu ft	55	
Abrasion loss, %	<3	
Side crushing strength, lb	50	
Carbon, as graphite (max.), %	5.0	
Na_2O (max.), %	0.04	
Iron oxide (max.), %	0.10	
Chlorine (max.), %	0.10	
Moisture (max.), %	3.0	

*Also 1/8 x 1/8 in. and 1/4 x 1/4 in. tablets and custom sizes.

G-35A is more economical for light hydrocarbons, while G-35B has advantage for heavier cuts. Both are active for naphthas and light cuts.

Regeneration is *in situ* to remove carbon and polymers using steam and air. Ultimate life is not yet known, however it is in excess of 1½ years.

Typical operating conditions with G-35 catalysts are: 600-750° F, 100-1000 psig, 0.5-20 v/hr/v, and a hydrogen rate of 300-3000 SCF/bbl feed. For mild naphtha treatment, possible conditions are 20 v/hr/v, 600° F, and 750 SCF/bbl hydrogen rate. More severe treatment of high boiling cylinder stock might be: 1 v/hr/v, 750° F, 500-1000 psig and 1500 SCF/bbl H_2 rate. Hydrogen is usually from catalytic reformer off-gas. Typical operating data follow:

	Texas Cracked Naphtha		Illinois Diesel Fuel		Okla Coker Gas Oil
Feedstock properties:					
Graviey,° API	36.5		63.8		27.4
ASTM dist., °F					
10%	295		425		502
50%	330		535		688
90%	385		675		855
EP	423		700		939
Sulfur, wt%	0.1134		0.16		0.480
Nitrogen, wt%	0.0057		0.008		——
Operating conditions:					
G-35 catalyst type	1/8-in.,A		3/16",B		1/8-in.,A
Pressure, psig	300	1000	300	1000	
Temperature, F	750	750	700	700	
Gas Rate,* SCF/bbl	1500	1500	1500	750	
Sulfur in product, wt%	0.0045	0.0016	0.011		0.086
Nitrogen in prod, wt%	0.013		——	——	

*Gas used was 80% hydrogen, 20% methane

Catalyst prices in quantities exceeding 20,000 lb (3/16 x 3/16 in. pellets) are $0.90/lb for G-35A and $0.95/lb for G-35B.

First unit using Girdler cobalt molybdenum catalyst was Ashland Oil & Refining Co. at Ashland, Ky.

For further information, contact the Catalyst Dept., The Girdler Co., Louisville 1, Ky.

Houdry Process Corp.

Manufactures several grades of cobalt molybdate hydrotreating catalysts, used by Houdry in "Guard Case" feed pretreatment units for Houdriformers and sold for general hydrotreating use in the industry.

A typical Houdry cobalt molybdate (on hard alumina) hydrotreating catalyst is the Series A, Grade 200, with the following properties:

CoO, min. wt%	2
MoO_3, min. wt%	8
Na_2O, max. wt.%	0.5
Bulk density, kg/l	0.92
Pellet density, kg/l	1.54
True density, kg/l	3.27
Surface area, m^2/g	195
Porosity, vol%	53
Absorption, wt%	34
Knife-edge hardness, g (min.)	6500
Crushing strength (4mm dia. pellet), lb	25+

The catalyst is pelleted to custom diameters.

Catalyst price varies with total metal content, and is supplied as a quotation to prospective customers.

Typical commercial performance of the catalyst is:

	Reformer Feed		No. 2 Fuel Oil
	Case 1	Case 2	
Temperature, °F	725	700	700
Pressure, psig	220	400	300
Space rate, v/hr/v	2.5	20	6
H_2/oil mol ratio	0.5	0.5	3.0
Sulfur in feed, wt%	0.501	0.04	0.5
Sulfur in prod., wt%	0.002	<0.006	0.1

Process condition ranges, using the cobalt molybdate catalyst are: 600-800° F, 200-900 psig, 2-20 v/hr/v, and a H_2/oil mol ratio of 0.25 and up.

Ten commercial units are using these catalysts.

For further information, contact Houdry Process Corp., 1528 Walnut St., Philadelphia 2, Penna.

Harshaw Chemical Co.

Manufactures cobalt molybdenum catalysts for desulfurization of petroleum streams. Some of the catalyst properties are:

CoO, %	3
MoO_3, %	9
Av. Side Crushing Strength (min.), lb	25
Color	blue-gray
Abrasion, %	<5

The catalyst is made into cylindrical pellets of equal diameter and length.

Regeneration *in situ* restores the catalyst to satisfactory operating activity.

Catalyst price is $1.00-1.08/lb, depending upon the quantity and tablet size ordered.

Harshaw Desulfurization catalyst has been used by over 20 of the largest refineries in the world.

For further information, contact The Harshaw Chemical Co., 1945 E. 97th St., Cleveland 6, Ohio.

For Hydrogen Processing

American Cyanamid Co.

Has patent and manufacturing rights to AERO HDS-1 Desulfurization Catalyst. The catalyst is said to be particularly applicable for middle distillates and heavier stocks, and to have a long onstream life, because of its high porosity. In addition, the low bulk density requires less catalyst for a given job. It is effective also for nitrogen removal and olefin saturation, and can be regenerated with steam-air mixtures.

Typical characteristics of the catalyst are:

CoO (dry basis), %	3
MoO_3 (dry basis), %	15
Al_2O_3 (dry basis), %	82
Tablet diameter, in.	3/16
Tablet length, in.	3/16
Crush strength, lb	31
Abrasion, %	0.7
Attrition, %	0.0
Bulk density, lb/cu ft	42
Tablet density, g/cc	1.05
Surface area, m^2/g	230
Pore volume (N_2), cc/g	0.47
Pore volume (total), cc/g	0.71
Loss on ignition (750°C), %	1.0

Price for AERO HDS-1 Desulfurization Catalyst is $1.25/lb. Because this catalyst was not marketed before July 1, 1956, it is too early to include commercial performance data.

For additional information, contact the Refinery Chemicals Department of American Cyanamid Co., 30 Rockefeller Plaza, New York 29, N. Y.

National Aluminate Corp.

National Aluminate Corp. is the sole manufacturer of Nalco Type RD-154 Desulfurization Catalyst.

This type of catalyst is said to be applicable to all refinery streams. Typical performance data is given in this report in the section "Processes You Can Use," describing the Sinclair Hydrogen Treating process.

Physical characteristics of Nalco Type RD-154 are:

Co + MoO_3, %	11-12
Catalyst base	alumina
Bulk density, lb/cu ft	47
Size (extrudate), in.	1/8
Color	blue
Attrition	average to better than average
Hardness (longitudinal per 1/8-in. length), lb	15

Catalyst life, regeneration and installations are discussed in the previous description of the Sinclair Hydrogen Treating process.

Catalyst price is $0.95/lb, plus the cost of shipping containers, F.O.B., Chicago, Ill.

For further information, contact the Catalyst Div. of National Aluminate Corp., 4001 W. 71st St., Chicago 29, Ill.

Oronite Chemical Co.

Manufactures "Oronite Hydrogenation Catalyst," first publically announced Sept., 1954. Some of the catalyst properties are:

CoO, %	3-3.5
MoO_3, %	9-12
Catalyst base	alumina
Pellet size, in.	3/16
Bulk density, lb/cu ft	60
Crushing strength, psi	50

Regeneration is *in situ* with oxgen-free flue gas used to remove sulfur, nitrogen and coke from the catalysts. Regeneration takes 2-6 hours, with total number of regenerations and ultimate catalyst life not yet known. However, first catalyst batches have been in service for over 18 months.

Catalyst price is $0.95/lb, F.O.B. Richmond, Calif., freight equalized with nearest competitive producing point. First commercial user of Oronite Hydrogenation Catalyst was Standard Oil Co. (Ind.).

For further information, contact the Oronite Chemical Co., 225 Bush St., San Francisco 20, Calif.

Peter Spence & Sons Ltd.

Manufacturers of COMOX catalysts for use in desulfurization, denitrification and general cleanup of petroleum streams, and in the refining of benzene. Applications include treating of petroleum streams from light naphthas (general cleanup of catalytic reformer feedstock) through heavy distillates.

Physical characteristics of COMOX catalysts are:

CoO, wt%	2.5-5
MoO_3, wt%	9-25
Na_2O (max.), wt%	0.15
Catalyst base	gamma alumina
Bulk density, lb/cu ft	55
Color	purplish
Pellet diameter,* in.	1/8
Pellet length,* in.	1/8
Crushing strength (min.), kg	5 (at 1/8-in.)
Attrition loss (max.), wt%	3

*This is the nominal pellet size (cylindrical with convex ends), with other available sizes of: 7/16 in., 5/16 in., and 7/32 in. Granules are also available in sizes of 1/2-1/4 in., 1/4-1/8 in.

Catalyst formulations for specific applications may include other metals and their oxides with the alumina base. Sometimes the catalyst is compounded with a fluoride modification that increases its activity.

Peter Spence & Sons will prepare laboratory, pilot plant, or tonnage quantities of catalysts to a customer's own formulations.

Catalyst price is approximately $1.16/lb depending on quantity, pellet size, etc., duty paid in N.Y.

For further information, contact Peter Spence & Sons Ltd., 1 Hill St., London W 1, Great Britain, or the U.S. representative, Chemical Manufacturing Co., 444 Madison Ave., New York, N. Y.

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Hydrogenation Patents

Anglo-Iranian Oil Co. Ltd.—2,357,741—**E. I. du Pont de Nemours & Co.**—2,642,463—**Shell Development Co.**—2,674,634—**Sinclair Refining Co.**—2,398,899—**Sun Oil Co.**—2,649,419—2,654,696—2,706,167—2,736,689—**Standard Oil Development Co.**—2,459,465—2,574,331—2,638,438—2,664,404—2,673,175—2,694,671—**Esso Research & Engineering Co.**—2,717,861—2,717,864—**Union Oil Co. of Calif.**—2,614,067—**Universal Oil Products Co.**—2,388,942—2,586,535—2,622,111.

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Gulf Research & Development Co.—2,446,602—2,585,337—2,602,773—2,640,009—2,662,846—2,700,014—2,700,015—2,723,943—**Houdry Process Corp.**—2,676,907—2,692,224—2,703,308—2,704,758—2,729,596—**Phillips Petroleum Co.**—2,619,450—2,715,603—**Sinclair Refining Co.**—2,674,635—2,738,307—**Standard Catalytic Co.**—2,333,500—2,358,879—**Standard I.G. Co.**—2,177,376—2,221,952—**Standard Oil Development Co.**—2,414,889—2,428,692—2,450,316—2,450,317—2,657,175—**The Texas Co.**—2,739,929—**Universal Oil Products Co.**—2,344,789—2,350,828.

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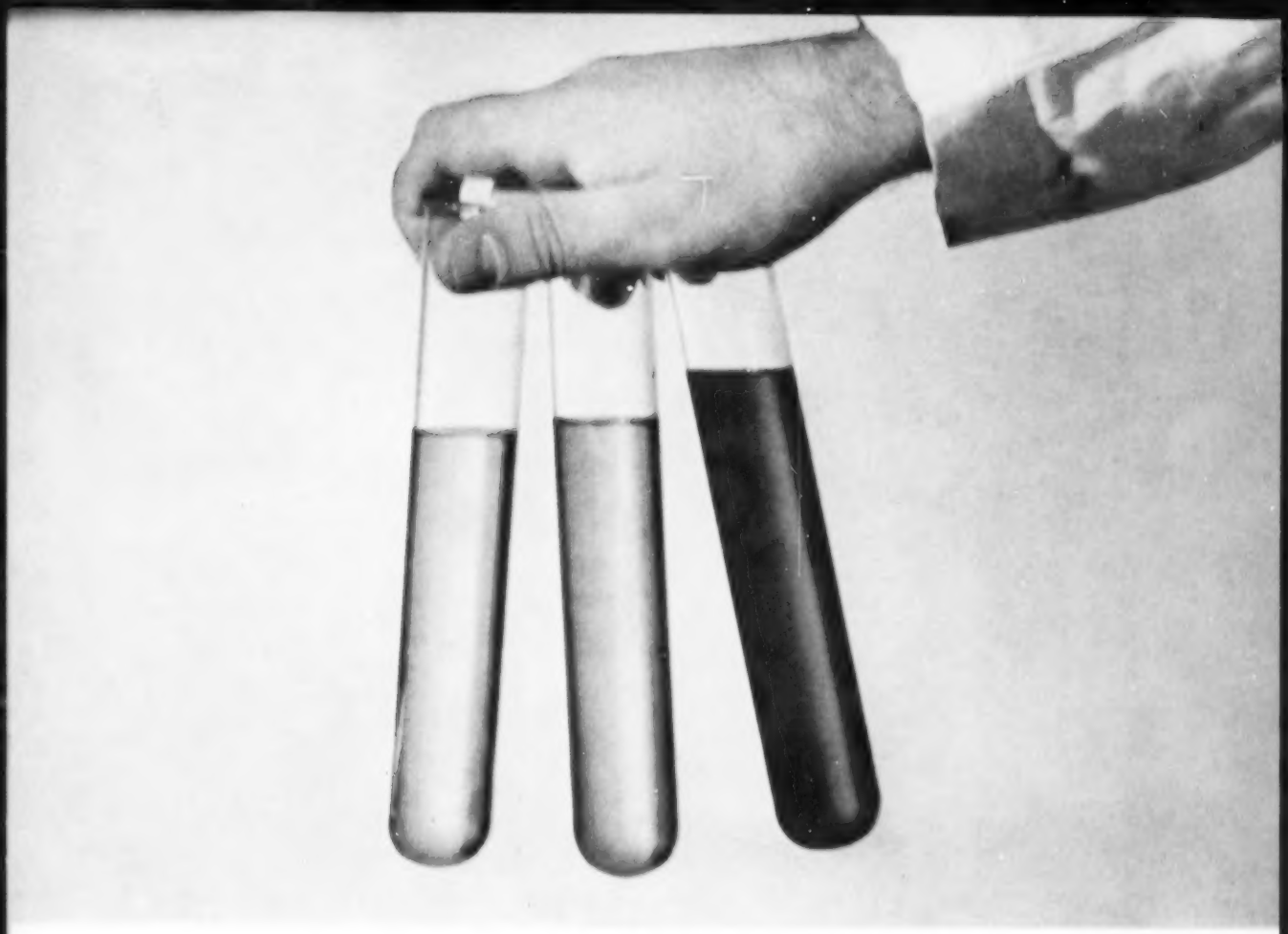

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"Clip-n-File" Process Data

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"Clip-n-File" Engineering Data

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p. 157

Ever Tried "Back-Slumping?"

Here's a technique for speeding up catalyst removal for faster cracking unit turnarounds, as developed at a Canadian refinery and reported in this month's Plant Practices, along with several other helpful operating tips. p. 149

Solly Was Working on Ulcers

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Secret of Better Visbreaking

. . . is feed preparation. This month's Patent Report tells how Gulf can get more gasoline and less coke by very deep reduction of crude before it is charged to a visbreaker. See also the new, easier-to-use Patents Listings. p. 167

Forecast on Forecasting

. . . the weather, that is. People who are doing something about the weather will tell API men in November what is reliable about today's long-range predictions and how the "art" is developing into a science. See Meetings. p. 173

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. . . of unplasticized polyvinyl chloride, one of the dozen of new products available today and reviewed in this month's What's New! Another new idea is an electric bunsen burner for the laboratory. For further details, turn to . . . p. 185

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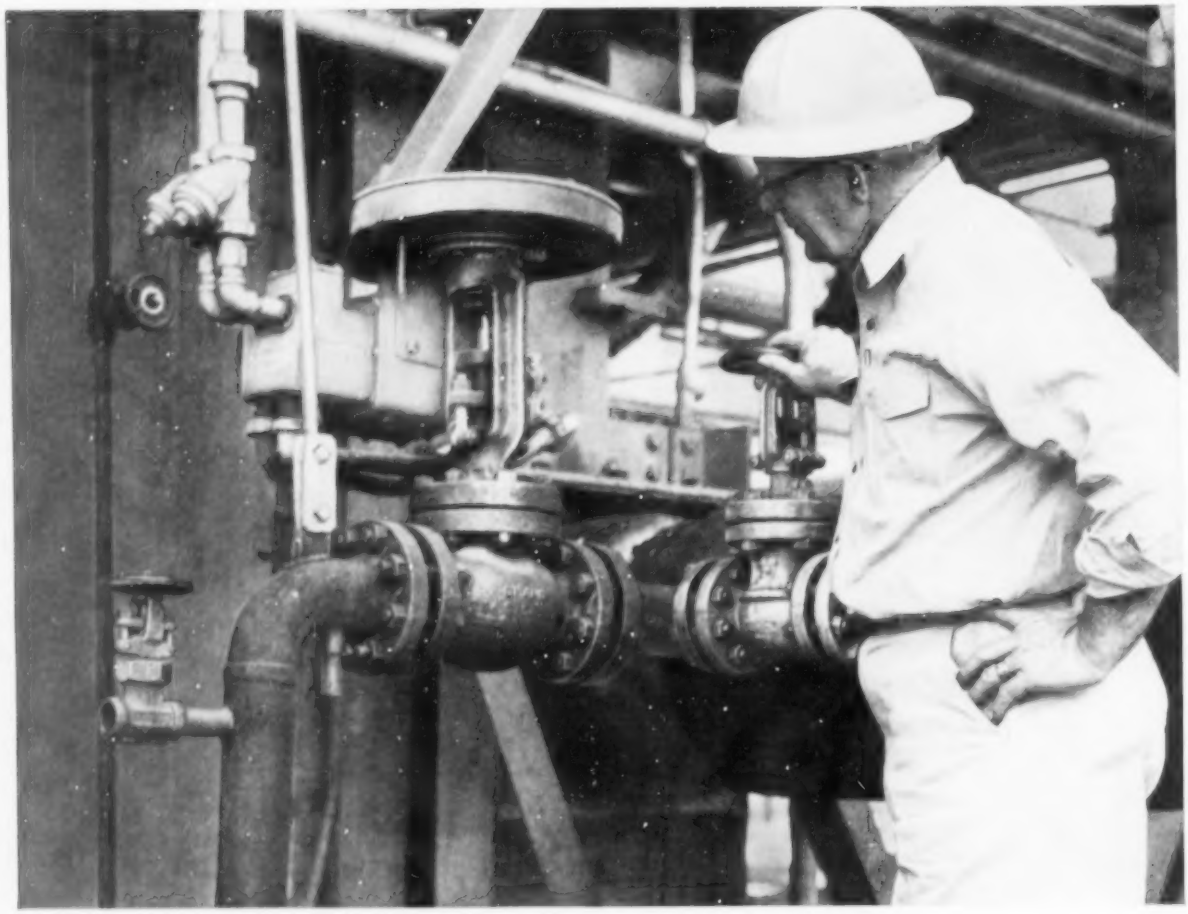

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Process Reference List—1955

Selected from the Pages of Petroleum Processing

Second of a new type cross-referencing index to speed literature surveys

Are you frustrated by conventional reference lists—can't locate specific subjects and information easily?

Here's the second of a series of new type process article reference lists (the first was PDS-9, Aug., 1956, pp. 101-3) with unique cross-reference index to save time and cut guesswork.

On these pages is a selected list of process references published in PETROLEUM PROCESSING during 1955. Each reference is coded. Here's how to use the index:

"Key" letters after page numbers in the article listings (Features, Tomorrow and Patents) tell "type" of information in each reference (see Article Classification Key).

"Cross-reference" letter-number combinations in the subject index tell you which article (F—Feature, T—Tomorrow, P—Patent) has information on the subject.

Article Classification Key

C=Chemistry or Formulae
D=Design Data and/or Methods
E=Economics, Costs and/or Markets
G=General or News Items
M=Materials and/or Equipment
O=Operating Conditions
P=Process or Plant Description
S=Schematic Flow Diagram
T=Theoretical Discussion
U=Utilities for Process
Y=Yields and/or Product Quality

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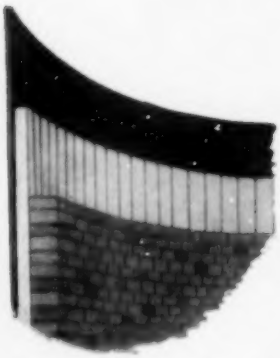

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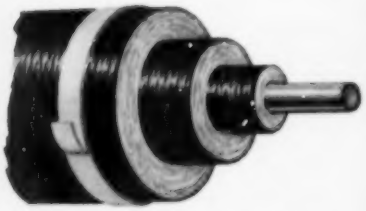

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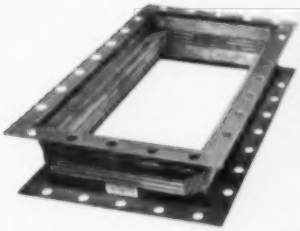
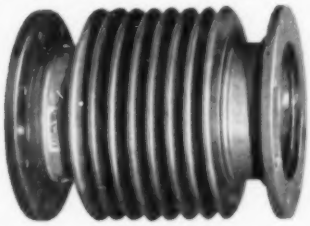
Sola-Flex bellows 



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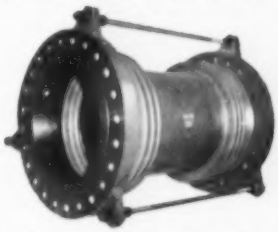
and varieties 

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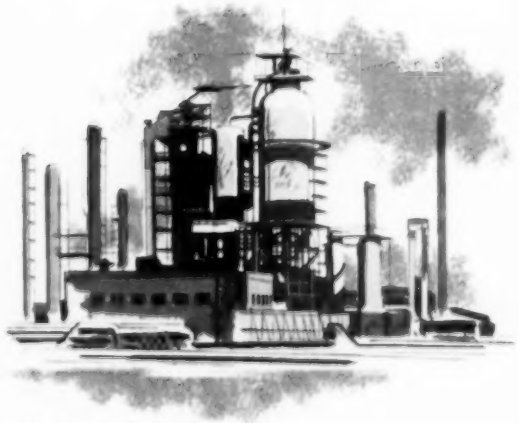

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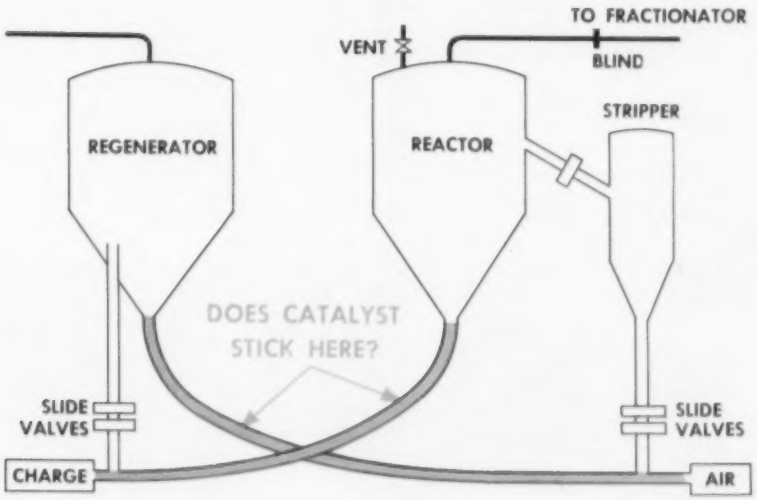


Try 'Back Slumping'

For Faster Turnarounds

By T. R. CULLY*

HERE'S a tip for improving your turnarounds. How would you like to start a Fluid unit shutdown on a Saturday and have the unit completely free of catalyst the following Monday morning at 8 o'clock—ready for all crafts to start their assignments?

Try "back-slumping." This is a relatively simple but effective technique developed and being used by McColl-Frontenac Oil Co. at their 50,000 b/d refinery in Montreal East, Que., for cleaning catalyst from the reactor and regenerator risers in the 23,000 b/d Fluid catalytic cracking unit before a turnaround.

The job used to take McColl-Frontenac up to a week digging out the extremely fine catalyst by conventional methods. During this period some of the craft departments could of course get to work. However, it was dirty, unpleasant work, and both the clean-out crews and the crafts took on their duties with considerable reluctance.

The new method is not only faster; it's more efficient. McColl found they were leaving too much catalyst in the unit with the old technique. The first time they used back-slumping, there was an estimated 20 tons remaining in the unit. The next time, this figure dropped to about 5 tons, and today it is virtually zero.

Man-power is less too. Men who used to be needed for the cleanouts are now free for other chores. The old method required an estimated 500 to 600 man-hours of maintenance department man power. Back-slumping requires no maintenance at all; it is handled by the regular unit operators.

Better housekeeping has been another advantage. The dusty, dirty catalyst that used to spread all over the Fluid unit area is now a rarity. Back-slumping confines the catalyst inside the unit.

Here is how back-slumping is done.

Conditions Prior to Back-Slumping

1—Maximum catalyst has been transferred from the reactor to the regenerator, and the regenerator is then unloaded as much as possible.

2—All bleeds and aeration connections are left open throughout the catalytic system.

3—A small amount of steam is left in the spent catalyst stripper, to keep the steam distribution spider clear.

4—The blind has been installed between the reactor and the fractionator.

5—Temperatures in the vessels are higher than 350°F., to reduce the danger of "mudding" the catalyst, due to condensed steam wetting it.

6—Sufficient dispersion steam is in the reactor riser to prevent catalyst from slumping and plugging the riser.

7—The reactor vent is open.

8—The following instruments are in operation:

a—Reactor top pressure indicator.

b—Pressure indicators above and below the regenerator and spent catalyst stripper slide valves.

c—Regenerator top pressure controller.

d—Regenerator bed level indicator.

e—Dispersion steam flow meter.

f—Spent catalyst stripping steam flow meter.

9—One blower is in service supplying aeration air and a small amount of carrier air to the regenerator riser.

Procedure for Back-Slumping

1—Reduce regenerator pressure to 3 or 4 psi.

2—Increase stripping steam to about 20,000 lb/hr and pinch in the reactor vent to build pressure in the reactor. (Note that the regenerator and spent catalyst stripper slide valves are closed.) Build up the reactor pressure until it is higher than the pressure above the regenerator slide valves—about 20 to 25 psi. should be ample.

3—While pressure is building up in the reactor, open one of the regenerator slide valves, leaving the other one closed.

4—When the reactor has been pressurized, quickly open the remaining regenerator slide valve and at the same time reduce the reactor dispersion steam to about 4,000 lb/hr.

5—When the pressure in the reactor has substantially equalized with the regenerator pressure, close one regenerator slide valve and re-pressure the reactor again. The dispersion steam should be put back into the reactor riser again at some safe amount to prevent any remaining catalyst from slumping back and plugging the riser.

6—Repeat the back-slumping procedure three or four times, until no further build-up is noted in the regenerator bed, or until opening of the slide valve produces an almost instantaneous equalization of reactor and regenerator pressures. At this point, the riser (as well as the regenerator stand-pipe) is free of catalyst.

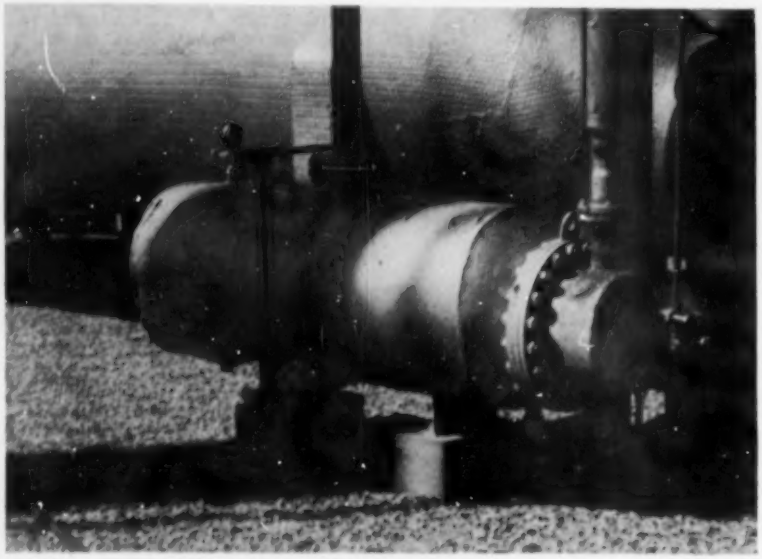
7—Use the same procedure to clear the spent catalyst stripper and stand-pipe. The regenerator and spent catalyst slide valves are closed and the reactor is pressurized as before. This

* Mr. T. R. Cully is general operating foreman, Montreal Works, McColl-Frontenac Oil Co. Ltd.

may also help to clear catalyst from the regenerator inlet line.

8—One spent catalyst slide valve is opened during pressuring, and the other is opened quickly when the desired pressure is attained in the reactor. The "sugar scoop" at the bottom of the spent catalyst stand-pipe will direct the steam up into the regenerator riser, carrying catalyst with it. Once again, as soon as reactor and regenerator pressures equalize quickly on opening of the slide valve, the riser can be assumed to be clean. The back-slumping of the regenerator riser—like that in the reactor riser—should be carried out three or four times to be sure the riser is clear.

Catalyst transferred to the regenerator by back-slumping the risers is then unloaded to the used catalyst hopper in the usual manner. Care should be taken that back-slumping does not take excessively long, otherwise "mudding" of the catalyst may occur.



DORCHESTER CORP. USES this old reboiler to advantage

For Natural Gasoline Plants

How to Adjust Residue Gas Btu's

AFTER stripping out the natural gasoline and liquefied petroleum gases from the feed gas, most natural gasoline recovery plants sell the residue gas under contract. These contracts usually require a certain minimum Btu content.

However, during winter operation, when condenser temperatures are low and operation is aimed at maximum propane recovery, the absorption of liquids from the feed gas is quite efficient. The result is often too low a Btu content for the residue gas.

The Dorchester Corp.'s Cargray natural gasoline plant near White

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In a tremendous variety of sizes and shapes, these new porous stainless steel filters are everywhere pushing back the temperature and pressure frontiers in micronic filtration. The reason: PORO-KLEAN's unique combination of physical properties. Its high strength, exceptional heat and corrosion resistance and adaptability to a wide variety of shapes makes it easy to apply both in industrial processing and in compact aircraft and missile hydraulic systems.

For instance take the tiny preformed shapes shown above. They are: cylinder (1), cup (2) and cup with lip (4)—all used to protect micro-finished aircraft hydraulic servo valves; disc (3) for oil filter, cylinder (5) with brazed-on seat for hydraulic O-ring; disc (6) for gas-turbine fuel-oil nozzle; cup (7) and (8) for diesel fuel-oil nozzle.

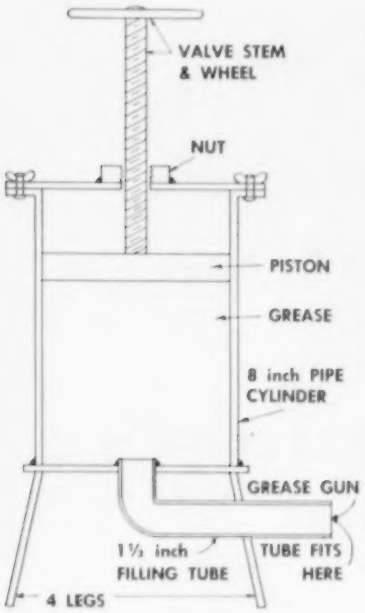
And, for the big jobs, you can get single or multiple PORO-KLEAN units like the 54-inch element (below, right). It's designed to filter synthetic polymer in a chemical plant with 1500 psi pressure drop and operation at 550°F.

If you have a tough filter problem, get all the details on Cuno PORO-KLEAN. You can be sure it will fit into your design. Write: The Cuno Engineering Corporation, 26-11 South Vine Street, Meriden, Connecticut. 62

CUNO ENGINEERED FILTRATION

AUTO-KLEAN (edge-type) • MICRO-KLEAN (fibre cartridge)
FLO-KLEAN (wire-wound) • PORO-KLEAN (porous stainless steel)

Deer, Texas, has developed a simple method for increasing the Btu content of the residue gas in order to meet minimum contract requirements. Liquid butane is brought from a line and vaporized in an old reboiler, then injected into the residue gas line. Butane rate to the reboiler is controlled by pumping butane into the residue scrubber that follows the primary absorber. The reboiler itself is steam heated, and can run full of butane, or dry, with no harm to the apparatus.



Grease Gun Filler Eliminates Messy Job

FILLING grease guns is a messy and time-consuming job when done by hand. A simple, easily-made gun filler at the Spear gasoline plant of the Gulf Oil Corp., Kilgore, Texas, eliminates a lot of the job's unpleasantness and results in better filled guns. And, it's quicker too.

A piece of 8-in. pipe, about two feet long, serves as a reservoir and pressure cylinder for the bulk grease. A piston screwed down by a scrap stem and wheel forces the grease out of the cylinder through a 1½-in. filling line into the tube of the grease gun. This simple filler has cut the normal loading time in half. It also gives a solid packed tube free of air bubbles and voids.

A hand-tight pipe cap on the end of the filling line keeps grease from running out when the filler is not in use.

INSULATION on towers, tanks and exchangers must be kept DRY. If moisture gets through, the efficiency drops.

Modern refinery and plant design places many major insulated vessels "in the open." You can maintain the efficiency of your insulation with easy-to-apply Laykold Weathercoat.

Weathercoat is a fibrated asphalt-base material of easy troweling consistency that dries to a black, remarkably tough and tenacious coating. A majority of the leading refineries are regular users of Weathercoat.

A new product: Mastic Weathercoat, a bodied material, for use wherever economy demands the application of a *single*, thick layer.

Write today for our free illustrated brochure, entitled "Laykold Weathercoat for Insulation Protection."

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 (To obtain more data on advertised products see page 182)

the ABILITY TO SERVE

The Warren **RESOURCES** . . . of production, of transportation . . . of storage . . . plus Warren **EXPERIENCE** as a specialist in its field . . . form a completely dependable **ABILITY** team.

That is why the Light Hydrocarbons Industry . . . natural gasoline and LP-Gas . . . **NATURALLY** looks to Warren for satisfying **SERVICE.**

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The Pump That Wouldn't Handle Air

"Solly, I'm surprised at you!"

SOLLY MORGAN, the operations superintendent, was working hard on a new set of ulcers. He was trying to put a newly revamped unit on stream and nothing seemed to be going right. The only thing on the whole unit that was going at this particular time was Solly, and believe me, he was going fast.

The operator on the unit was Dusty Rhodes. (I guess I must know a hundred guys named Rhodes, and they all answer to "Dusty.") Dusty came into the Bull Pen with that harassed new-unit look and I knew Solly would be reaching for his pills any minute. "Solly, that new gasoline pump ain't workin' right—keeps losing suction."

"Dusty, I told you that you'd have to keep that accumulator full or this very thing would happen."

"Listen, Solly, I've gone over the book on this pump and it just won't work. The accumulator is full, the suction line is tight, there's plenty of liquid gettin' to the pump, the casing is vented, but the damn thing just won't keep a suction."

"Then our bright construction boys have got the wrong speed on the turbine." Solly was working on a big ulcer this time—usually he blows up like a Roman candle when anything goes wrong. When Solly takes things sorta calm-like, he is usually cultivating a new crop of stomach grinders.

I was vaguely familiar with Solly's problem child. We had put in this new gasoline pump on the re-vamp job. It was a turbine-driven centrifugal pump that took suction from an overhead accumulator through a new 6-in. line in the pump-out trench. And now it kept losing suction. Frankly, I had visions of a lunch bucket or wad of old rags left in the line by mistake during installation. But I didn't say anything to Solly—he was hard to get along with when he was calm and his ulcers were simmering.

"Well, dammit, Dusty, finish your coffee and let's get this show on the road. Call Dutch and have him get a machinist over there right away." Solly was out the door and off before Dusty could answer.

Well, I was in and out of the Bull Pen all day and I could tell by the tone of the place that Solly's ulcers were giving him a fit, even though I didn't see Solly until late afternoon. The telephone would ring and I could hear Solly's voice yelling for more pipefitters, another machinist, an instrument man.

Finally Dan Miretti came in, "Look, you gotta come over and give me a hand with that new pump. Solly's about to drive me nuts!"

"Has he blown his top yet?" I asked.

"No, but he's due any minute."

"No dice, I don't like to be around Solly when he's calm."

"What's Solly's trouble now?" It was the Old Man who had just stepped in the back door.

I brought him up to date on the troublesome pump—at least all that I knew about it.

"Let's get over there and see what's goin' on." It looked like I was hooked.

When we got to the unit, Solly had enough people gathered around that pump to take care of the liquid it would handle in buckets. But he was still calm—amazing!

We watched Dusty bring the pump up for what must have been the twentieth time that afternoon. It would rock along for awhile, then the needle on the discharge pressure gage would start gyrating like a dog chasing its tail.

"See what I mean?" Solly wailed.

The Old Man poked around the accumulator drum, watching the level. Then, he strolled along the suction piping and traced it down to the pump.

The piping at the pump elled up out of the trench, turned 90° across the trench, reduced to a 3-in. line and elled at the pump into the suction connection. The distance from the centerline of the suction to the riser from the trench was about ten feet. The Old Man was gazing suspiciously at some places on this ten-foot run.

"Give me a level, Nasty," he said to "Nasty" Herbert. The Old Man ran the level along the top of the piping at the pump.

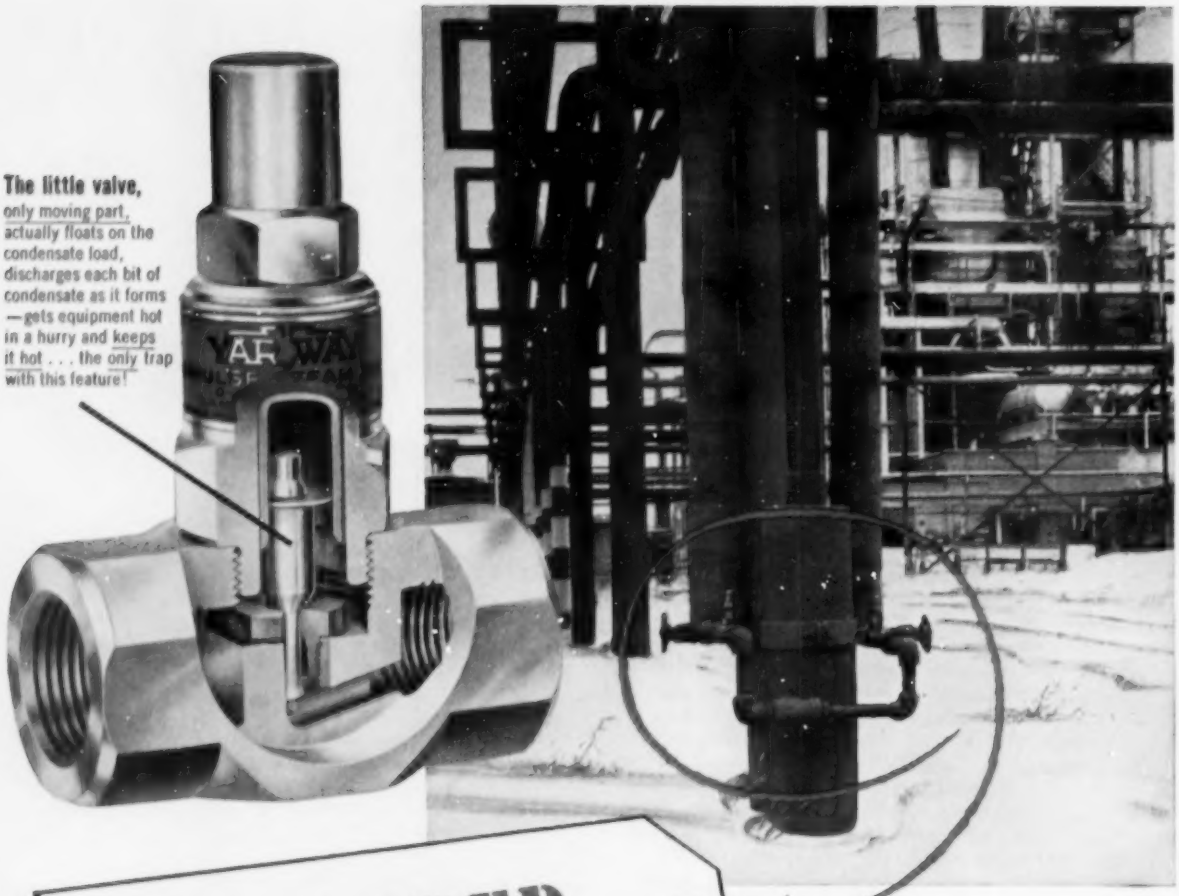
"Solly, I'm surprised at you. Jerk out that detail and have a welder cut about three inches out of that vertical riser and your troubles will be over."

I went over a little closer to see what had tipped the Old Man off, because you sure couldn't see any holes in that pipe. In setting the pump, the construction crew had not tried to make the pipe fit, but had heated the horizontal run to take the strain off the pump. The torch marks on the unpainted pipe told the story. In effect, they had sloped the pipe toward the pump and left a high place at the top of the riser. Now everybody knows that you can vent a pump casing all day, but if you have high spots in the line, you're gonna have air slugs.

The three inches we cut out of the riser sloped the pipe back toward the trench eliminating possible air traps.

Next morning, when the piping was back in place, Dusty put the pump on and she took right off. Of course, Solly was pleased, but the happiest person in the whole refinery was Dutch Kriger, our maintenance boss.

"Maybe Solly'll let me drink my coffee in peace for a change!"



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Is your plant ready for cold weather?

Steam lines and process equipment equipped with Yarway Impulse Steam Traps *are* prepared for winter:

. . . protected against freeze-ups.

. . . capable of operating at high even temperatures.

. . . ready for peak production loads.

The little valve of the Yarway Impulse Steam Trap (only moving part) continually tests for condensate, discharges each bit as it forms, prevents freezing.

Combined with other important Yarway features—fast equipment heat-up, stainless steel construction, small size, light weight, good for all pressures without adjustment, low initial cost—this adds up to *the best winter trapping you can buy.*

Check your traps now. Then call the Yarway distributor for the Impulse Traps you need. 270 of these distributors, one near you. We'll gladly send you his name also the latest Yarway Steam Trap Bulletin. Write to . . .

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The Impulse that revolutionized steam trapping 20 years ago.

 (To obtain more data on advertised products see page 182)

Do You Know These Words?

By B. H. WEIL
Manager, Information Services
Ethyl Corp. Res. & Engrg. Dept.
Detroit, Mich.

A regular department intended to help both administrators and operating men keep abreast of technical names and processes in the petrochemical field.

Anisaldehyde

Anisaldehyde, pronounced **"ann-is-al-**duh-hide," is today a petrochemical by virtue of its increasing synthesis from *para*-cresol. It is a colorless to pale yellow liquid, of hawthornlike odor, which is slightly heavier than water per unit volume. It has the same freezing point as the latter material, but boils at a far higher temperature.

Also known as anisic aldehyde, this petrochemical has the formula C_6H_4-$(OCH_3)CHO$, with the -CHO group in the *para* position on the benzene ring from the $-OCH_3$ group (i. e., attached to the third carbon atom from that to which the latter group is affixed). Anisaldehyde finds use in perfumery, as an intermediate for antihistamines, and—in increasing quantities—as an intermediate in the manufacture of synthetic hormones.

Anisaldehyde is synthesized from either anethole or anisole, by oxidation. The first of these is prepared synthetically from *para*-cresol, which in turn is produced by separation from the other cresols in cresylic acids; by synthesis from toluene; or by synthesis from benzene via the cumene process. All three base materials—cresylic acids, toluene, and benzene—are produced commercially from petroleum. Cresylic acids are made by separation from cracked products, benzene and toluene from the catalytic reforming of naphthas.

It is indicative of the ever-widening scope of the petrochemicals field that this particular petrochemical, anisaldehyde, has such "modern" uses as the synthesis of antihistamines and synthetic hormones. While it has long been theoretically possible to synthesize versatile intermediates from petroleum, only recently has this also become economic.

Acetone

Acetone, pronounced **"ass-**eh-tone," is a petrochemical of long standing. It has the formula $CH_3 \cdot CO \cdot CH_3$—indicative of another of its names, dimethylketone—and has a characteristic fragrant odor. A liquid, it is colorless, flammable, lighter than water, and considerably more volatile; it solidifies far below the freezing point of water.

Acetone has long been used as a solvent for nitrocellulose and in protective coatings and adhesives. It is also used as an absorbent for acetylene. Besides, it is a versatile chemical intermediate in the synthesis of such important chemicals as acetic anhydride, diacetone alcohol, and mesityl oxide. One very recent use is in the synthesis of vitamin A, beta-carotene, vitamin E, and a whole series of perfume bases and "vegetable" pigments for food coloring. These resulted from research on substitutes for lemon grass oil in the synthesis of Vitamin A.

Acetone is produced commercially by the oxidation of isopropyl alcohol (from propylene), by the oxidation of cumene (from propylene and benzene, as a byproduct in phenol synthesis), and by the oxidation of natural gas. It can also be produced by fermentation of carbohydrates. As is well known, propylene is a constituent of refinery cracked gases, or is deliberately produced by the cracking of propane, while benzene is separated from catalytically reformed naphthas.

The synthesis of vitamins, previously mentioned, may be a new use for acetone, but it is not necessarily a surprising one, for acetone has a chemical structure which renders it highly reactive and suitable for use in the synthesis of complex chemicals. Use as a general-purpose solvent is also firmly entrenched. This veteran petrochemical apparently faces an excellent future.

NEWS in VIEWS

GIANT COLLAPSIBLE TANKS have successfully completed tests under actual operating conditions in the southwestern oil fields. The tanks are made of tough, rubberized nylon and have a 15,000-gal capacity. When filled they measure 45-ft long, 11-ft wide, and 6-ft high. As the photo at the right shows, they can be rolled up like a sleeping bag into a package eight feet long by two and one-half in diameter.

The tanks are designed by their manufacturer, Firestone Tire & Rubber Co, to avoid some of the transportation and storage problems of steel tanks. Rupturing from overloading is impossible because of a pressure release system built in at Firestone's Magnolia, Ark., plant.

Think of the design freedom this clad steel would give us!

...and it costs less in the long run!

Clad steel demonstration unit featured at Trade Fair of the Atomic Industry.

SEE THE DIFFERENCE!

SEE FOR YOURSELF!

ECONOMY—high-alloy layer assures corrosion resistance, long equipment life.

STRUCTURAL STABILTY—low-cost backing steel provides strength and rigidity.

DESIGN FREEDOM—integral bond allows design and fabrication of shapes to meet process and space needs.

■ When you compare clad steel with other materials for price, lasting quality, easy adaptability and low maintenance . . . the *difference* is clear! Experience shows that in tanks and pressure vessels, *clad steel spells economy every time!*

Clad steel offers the protection and long equipment life of solid high alloy—at a down-to-earth cost! That's why it's steadily growing in use throughout the petroleum industry—in fractionating towers, desulphurizers and other vital equipment.

The permanent bond between cladding and backing metals actually simplifies construction—eliminates seepage and crevice corrosion. And clad steel equipment is easily modified. Walls can be cut, flanges or pipes welded on without harm to clad surface or bond. Maintenance, too, is much simpler. Those smooth, high alloy walls are easily cleaned and inspected.

Only Lukens offers a selection of 16 cladding and 11 backing metals—giving you practically an unlimited choice to combine as your needs may require.

For more information, consult your equipment builders or write to Manager, Marketing Service, Lukens Steel Company, 841 Lukens Building, Coatesville, Pennsylvania. We'll show you in detail just why we say *clad steel is the ideal material for long range economy.*

LUKENS CLAD STEELS

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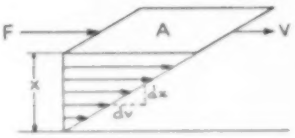
Petroleum

Viscosity Measurements



F = Force required to move plane
A = Area of plane
V = Velocity of plane, due to the force

In Newton's analysis he assumed:

$F/A \sim dv/dx$ or $F/A = \text{a constant} \times dv/dx$

This constant, μ, he called "viscosity", so that

$$\mu = \frac{F/A}{dv/dx} = \frac{\text{dynes/sq cm}}{(\text{cm/sec})/\text{cm}} = \frac{\text{gm}}{(\text{cm})(\text{sec})}$$

1 gm/(cm)(sec) = 1 poise

VISCOSITY—What Is It: In simple terms viscosity is the measure of a fluid's internal friction. It tells whether a liquid is "thick" or "thin," and how well it will pour at various temperatures. It is expressed in either absolute or relative values.

When one layer of fluid moves relative to another, as does plate *A* in the accompanying sketch, a definite force is required to overcome the friction between two adjoining fluid layers. The velocity of the plate (or fluid layer) is proportional to its distance from the stationary surface. The relationship between this force and the area of the plate is called "viscosity."

By Newton's analysis, the physical dimensions of viscosity are *(dynes)(sec)/sq cm*, or *grams/(cm)(sec)*. Although the viscosity can be expressed in engineering terms of *lb/(ft)(sec)*, it is not common practice. But for conversion purposes, 1 lb/(ft)(sec) = 14.88 gm/(cm)(sec).

METHODS IN MEASURING VISCOSITY: It might seem that there are countless methods of measuring viscosity. There are many accepted procedures but all of them fall into the general classifications pictured here.

The devices used to obtain empirical measurements of viscosity are called viscometers (or viscosimeters), with all of them dependent upon the existence of laminar flow under certain controlled and reproducible conditions. Instead of the absolute measurement (as described in the analysis above), the value as determined by viscometers is in experimetal dimensions—usually seconds of time. These values can be converted into absolute terms by the chart on the reverse side of this data sheet.

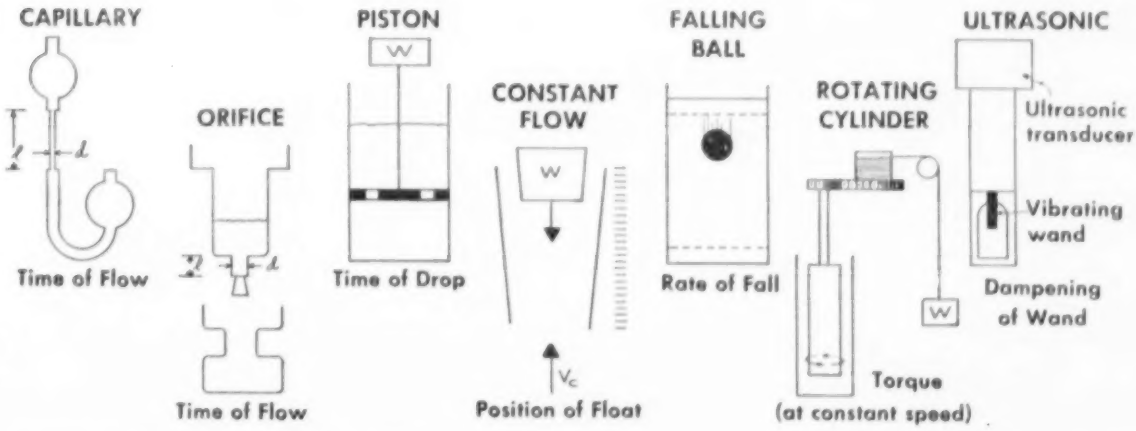
The method normally used for laboratory determination of viscosity is the Saybolt Test, as defined by ASTM standards. Results are usually expressed in "seconds Saybolt Universal" (S.S.U.) or "seconds Saybolt Furol." Both of these ratings are the actual seconds required for 60 ml of the test liquid to flow through an accurately sized orifice at constant temperature conditions. (The temperature is usually part of the rating, e.g., "200 S.S.U. at 100°F.") Thus a high Saybolt reading means that the liquid is thick (or viscous), while a low reading of Saybolt value indicates that the liquid required a short time to run through the orifice and is therefore thin or less viscous.

Similar tests are run in Great Britain but the value is expressed as "Redwood," while in Europe the values are expressed in terms of "Engler."

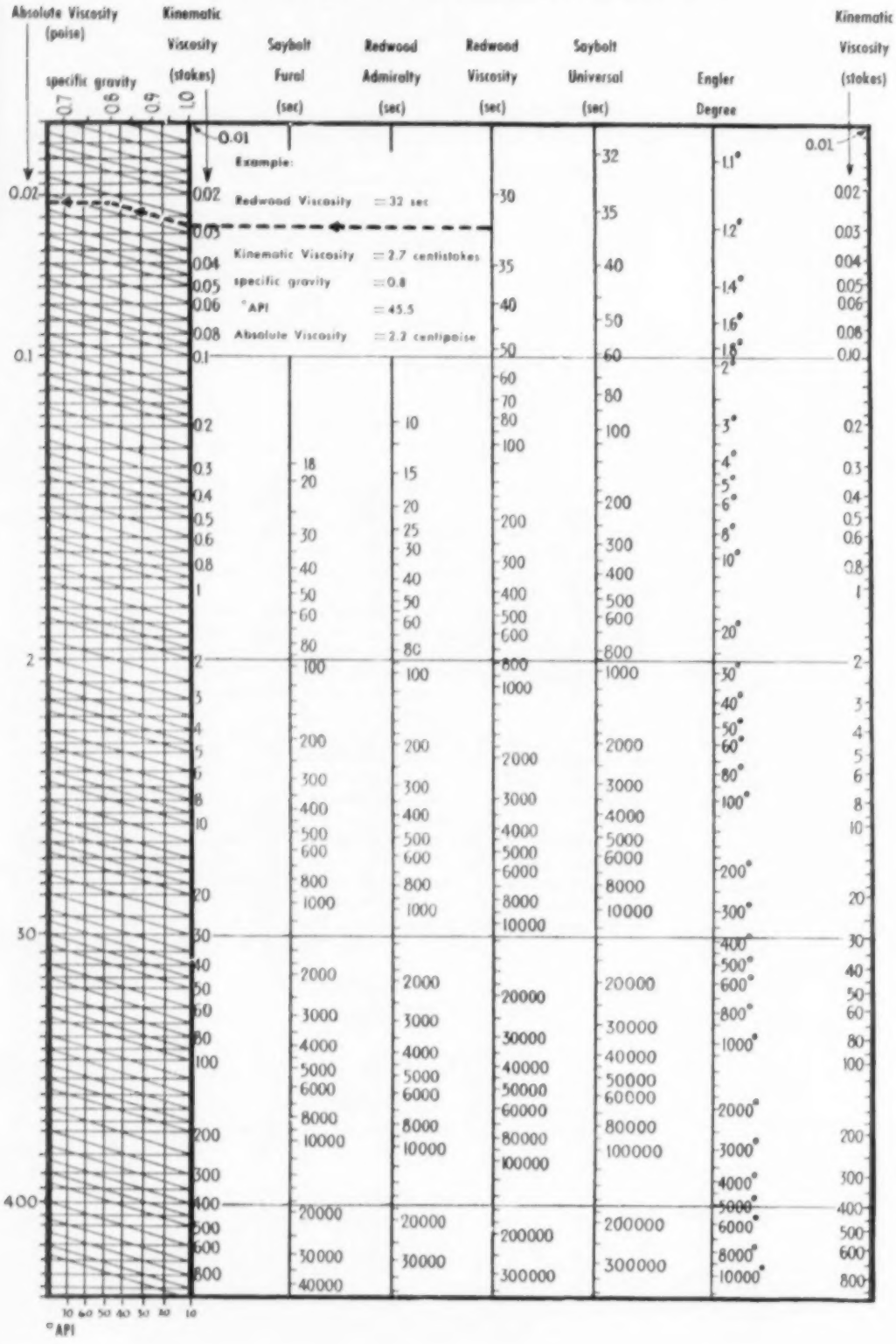
ABSOLUTE OR KINEMATIC VISCOSITY: In the first analysis of viscosity above, it was defined in dimensional terms of "grams per centimeter per second." In this system 1 gm/(cm)(sec) = 1 poise. A more useful term is the centipoise, or one one-hundredth of a poise.

In petroleum analysis, another method of expressing viscosity is normally used—the kinematic viscosity. This is the quotient of the absolute viscosity divided by the density of the liquid at the same temperature. It is more often used because it is expressed in simpler terms of "square centimeters per second," and is a term found in fluid flow problems. The term used for kinematic viscosity is the "centistoke," which is equal to 0.01 sq cm/ sec.

Another way to compare viscosities is to relate the behavior of oil with that of water. Since water has a convenient value of 1 centistoke at a temperature of 68.4°C, this is an easy comparison to make. In fact, one viscosity value (Engler degree) is the numerical ratio between the viscosity of the test liquid and that of water.



Viscosity Conversion Chart



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Samuel A. Montgomery has been named vice-president for manufacturing of Standard Oil Co. (Ind.) He succeeds **Dr. Max Paulus,** who has retired after 41 years' service. Montgomery was previously general manager of manufacturing.

Joseph K. Roberts, formerly general manager of research and development, has been elected vice-president for research and development.

Jesse C. Ducommun, who continues as assistant general manager of manufacturing, has joined the board of directors to fill the vacancy left by the retirement of Dr. Paulus.

Dan M. Krausse, manager of manufacturing for Cosden Petroleum Corp., Big Spring, Tex., has been promoted to vice-president of manufacturing.

John F. Daley, general manager of Du Pont Co.'s organic chemicals department, has been promoted to vice-president, director, and member of the company's executive committee.

Mr. Daley

The petroleum chemicals division is one of the four sales divisions under Daley's managership. He is a director of the American Petroleum Institute.

Succeeding Daley is Samuel G. Baker, formerly general manager of the photo products division.

Dr. E. P. King, superintendent of the technical department at Pure Oil Co.'s Smiths Bluff refinery, has been transferred to the home office in Chicago to head a group in the operating division of the refining department that is studying electronic computers in refining operations.

Norman Banta, former superintendent of the light oil and cracking department, has succeeded King.

William E. Norris has been transferred to Chicago to work with King. He has been supervisor of the oil accounting section since 1948. Before that he was a chemist in the refinery.

Victor H. Trumpy, former superintendent of operations at the Toledo refinery, has joined the Smiths Bluff plant as technical foreman.

Marvin Keemey, former yield supervisor at the Cabin Creek, W. Va., plant, has become maintenance foreman at Smiths Bluff.

Succeeding Trumpy at Toledo is **J. N. West,** who was a general operating foreman.

Assistant superintendent of operations, a new post, is **H. E. Zachman,** formerly a general operating foreman.

The promotions to general operating foreman at Toledo included **D. O. Parsons, F. A. Duesing, D. S. Bright,** and **A. E. Gibbs.**

O. Rothlisberger, formerly a chemist, has been named inspector supervisor.

Dr. Francis T. Wadsworth has been appointed assistant director of the research and development department of American Oil Co., Texas City. He was previously head of the chemicals section and now is in charge of the research division.

He holds an A.B. degree in chemistry from Missouri State College, received in 1939. He was awarded an M.S. in chemistry from the University of Missouri in 1941 and a doctorate from the same school in 1947.

He began with Amoco in 1942.

Carl C. Georgian has been appointed group leader in the technical service division, research and development department.

He joined the company in 1952 and was transferred to the technical service section in 1955.

Robert M. Caplan III, formerly with Esso Standard Oil Co., has joined Cresap, McCormick and Paget, management consulting firm of New York, Chicago and Washington. Caplan was an engineer in the economics and planning division of Esso's Everett refinery. He is a senior associate in the general management division of the consulting firm.

In addition to a B.S. in chemical engineering from Cornell University, Caplan has an M.B.A. degree from the Harvard Graduate School of Business, where he held the Teagle Scholarship of Standard Oil Co. (N. J.)

The following are further appointments to Tidewater Oil Co.'s new Delaware refinery.

Elwood C. Bailey to supervisor of the crude area, from cat cracker engineer at the company's Avon, Calif., refinery. The next four men were also transferred from Avon.

Robert C. Carter to supervisor of

Oil Men on the Tail of the Weather Man

THE oil industry is pushing research into long-range weather forecasting. Two years ago, in the hope of putting more science into what is now so largely an art, the American Petroleum Institute formed a committee of oil men to follow developments in weather forecasting and to support promising fundamental research. The Advisory Committee on Fundamental Research on Weather Forecasting, as it is known, is made up of people from the top drawer of oil industry research. Chairman is Dr. W. J. Sweeney, vice-president of Esso Research & Engineering Co. Other current members are:

Dr. Sweeney

R. C. Alden, research coordinator, Phillips Petroleum Co.

L. C. Beard, Jr., assistant director, Socony Mobil Laboratories.

R. B. Bowman, associate director of oil field research activities, California Research Corp.

F. L. Hartley, general manager, research department, Union Oil Co. of California.

Dr. W. E. Kuhn, general manager, research and technical departments, The Texas Co.

M. H. Parks, supervisory petroleum engineer, Humble Oil & Refining Co.

F. C. Roop, section head, engineering research department, Standard Oil Co. (Ind.)

W. W. Scheumann, vice-president and manager, Cities Service Research & Development Co.

N. D. Smith, Jr., vice-president, exploration and production research, Shell Development Co.

B. B. Wescott, assistant to the executive vice-president, Gulf Research & Development Corp.

Elmer Mattocks, assistant director, department of technical services, API.

The committee will sponsor its first activity at an API meeting when the association meets this month in Chicago. See Meetings (p. 173).

the cracking area, from technical operating foreman of the cat cracker.

Roger W. Edwards to supervisor of the alkylation and polymerization area, from operating foreman of the light crude distillation plant.

Gordon G. Gaddis to supervisor of the reforming area, from technical foreman of the solvent light oil treating plant.

Paul W. Jepsen to supervisor of oil dispatching, from night superintendent.

John J. Mack to chief engineer, from working with the C. F. Braun & Co. in planning the engineering details of the refinery.

John Searl to supervisor of the utilities and sulfur recovery area, from superintendent of the power station at Tidewater's former refinery at Bayonne.

Clarence E. Slater to supervisor of the coking area, from Avon, where he was mechanical engineer.

Vincent J. Tkac to supervisor of control laboratories, from the Bayonne refinery.

Adam J. Transou to supervisor of inspection, from work with C. F. Braun & Co.

At Avon, these promotions have been announced:

Edward F. Courtney to superintendent of shipping and utilities, from acting superintendent of treating and lube facilities.

Carl C. Groscup to one of four night superintendents, from shift foreman of the alkylation, isomerization, and solvent and light oil-treating plants.

Wayne Dykksten to supervisor of solvent and light oil treating, from operations foreman in the alkylation and isomerization plants.

Frank H. Farmer to supervisor of plant utilities, from general foreman of the electric shop.

In addition, **Dr. John W. Bishop,** research group leader in Tidewater's eastern division, has been transferred to the company's headquarters in San Francisco, where he will work with the electronic data processing study group with offices at Avon.

Herbert Minich has been transferred from Esso Standard Oil Co.'s East Coast technical service department to the refining coordination department of Standard Oil Co. (N. J.) He will specialize in the cordination of chemical products processing.

Minich's post in technical service, head of economics, has been assumed by **Brooke Pietsch,** who was head of the refinery processing section of the technical service division. This job has been filled by **Don MacIntyre,** who moved from the additives division, giving this responsibility to **Bill Lohr,** until now MacIntyre's assistant in the paratone section.

William Dean Scallorn has been added to the technical staff of Stauffer Chemical Co.'s Hammond, Ind., plant. He is a 1956 B.S. graduate of the University of Texas and previously worked at the Fort Worth plant of Stauffer's Consolidated Chemicals Division.

Dr. Bernard L. Evering has been appointed a senior research associate in the Standard Oil Co. (Ind.) research department, Whiting, Ind. He will head a staff of organic research scientists in a long-range program to develop improved gasolines for requirements 10 years from now.

Dr. Evering

His most recent assignment was to direct fundamental research on a method for making polyethylene by using solid catalysts.

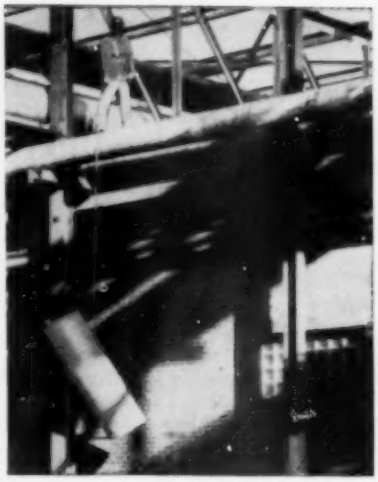
James W. Bateman has been appointed director of the new projects division in Continental Oil Co.'s coordinating and planning department. He was formerly technical assistant to the manager of manufacturing.

John M. Brown has been appointed manager of the El Dorado refinery of Pan-Am Southern Corp. He succeeds **E. N. Kimes,** who has retired. Brown was assistant manager, and this post has been taken by **H. K. Wheeler,** formerly assistant manager-technical.

J. D. Walk, formerly with the manufacturing department of American Oil Co., has transferred to El Dorado to serve as superintendent-technical.

Murray T. Hamilton, safety superintendent of General Petroleum Corp's Torrance refinery, has been promoted to manager of the company's safety department. He has been in fire protection work for the company since 1946.

Elmer R. Erickson has been elected president of Northwestern Refining Co., St. Paul Park, Minn. He was



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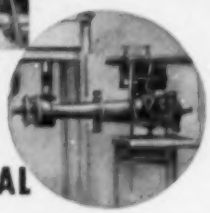

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Exclusively for vertical firing, the new National Airoil VERTICAL Tandem Block Units retain all the features of our regular horizontal Tandem Units . . . *plus:* special, pre-cast refractory shapes for easier, cost-saving vertical installation and maintenance; secondary air inlet louvres for positive control of vertical flame pattern; and, all steel duplex detaching gear which enables swift, simple vertical burner changeover.

VERTICAL and HORIZONTAL Tandem Units hold air in the combustion zone until fuel and heated air are thoroughly mixed. This means that ignition takes place in a hot zone; the result: high fuel economy through more rapid combustion with a minimum of excess air. NATIONAL AIROIL's patented Tandem Combustion Units allow secondary air to be easily and accurately controlled. By adjusting air control louvres, flame can be shaped to radiate heat uniformly without tube impingement.

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"Many, many more hours on stream, without shutdown" . . . yes, YOU will realize higher profits from YOUR heaters when NATIONAL AIROIL VERTICAL or HORIZONTAL Tandem Units are specified. Our new Bulletin 498 is yours for the asking.

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INDUSTRIAL OIL BURNERS, GAS BURNERS, AND FURNACE EQUIPMENT

formerly executive vice-president and secretary of the company. He has been with the company since its founding 17 years ago and is also a director. He succeeds his brother, **Arthur T. Erickson,** who has given up the presidency to devote his full attention to other business interests in the area. He continues as a director.

Guy B. Hunter, president of Quaker State Oil Refining Corp., was re-elected president of the National Petroleum Association at the group's recent annual meeting in Atlantic City.

Mr. Hunter

Paul R. Beck, Pennsylvania Refining Corp., was named first vice-president.

Rexford S. Blazer, Ashland Oil & Refining Co., became second vice-president.

Treasurer will be the second post held by President Hunter.

F. C. Cutting has become assistant to the vice-president of personnel and industrial relations at Shell Oil Co.'s Martinez, Calif., refinery. He was assistant to the vice-president for economic development.

J. E. Marsland, manager of the head office manufacturing technological department, has been made assistant to the executive vice-president.

J. M. Brackenbury, superintendent at Martinez, has succeeded Marsland at the head office.

J. B. Dunlap, assistant superintendent, has taken the superintendent's post.

J. B. St. Clair, assistant manager of the head office manufacturing technological department, has succeeded Dunlap at Martinez.

H. E. Walker is St. Clair's successor in the head office. He was chief research technologist at the Houston manufacturing research laboratory.

Delbert J. Massey has been appointed a project specialist in the development department of Monsanto Chemical Co.'s organic chemicals division. He was a research chemist in the division, and will join the development department's rubber chemicals section at Nitro, W. Va.

Dr. Bruno G. Wojcik has been named manager of research and development for the industrial chemicals division of Olin Mathieson Chemical Corp. He is located in Baltimore.

Wojcik formerly was in charge of inorganic research for the division.

George H. Meason, formerly with the technical and research department of Humble Oil & Refining, Baytown, has joined Tennessee Gas Transmission Co. as chief process engineer. He will develop a technical organization within TGT's plants and processing department. His last post at Humble was as acting assistant division head of the technical service division.

Richard W. Kersey has been appointed chief process engineer of the Derby Refining Co., Wichita, Kan. Before joining Derby, Kersey was chief process engineer for Southwestern Engineering Co., Los Angeles. He is a 1944 graduate of the University of Southern California.

R. T. Watson, for 36 years a member of British American Oil Co.'s manufacturing department, has retired. His last post was as manager of the Edmonton refinery. He began with the company in 1920 as a warehouseman at the Toronto refinery.

Dr. Hougen

Dr. Williams

Dr. Joel O. Hougen and **Dr. Theodore J. Williams** have become members of the engineering department of Monsanto Chemical Co.'s research and engineering division. Both will join a new section in the department concerned with special research in automatic control of chemical processes.

Hougen has been professor of chemical engineering at Rensselaer Polytechnic Institute since 1948. Williams has been assistant professor of chemical engineering at the U. S. Air Force Institute of Technology, Wright-Patterson Air Force Base, since 1954.

Richard W. Davis and **Fred Davenport** have joined the technical staff of Stauffer Chemical Co. at Richmond, Calif. Davis is a chemist, Davenport a chemical engineer.

Four Promoted at Rockwell

Paul A. Mankin, general manager of Rockwell Manufacturing Co.'s Pittsburgh division, has been appointed chief engineer of the new central liquid meter research and development department in Pittsburgh. He will take charge of the petroleum, industrial liquid and water meter research and development programs. He will also be in charge of the meter and valve testing station near Murrysville.

Three plant managers have been promoted in the meter and valve division. W. M. Connor, general manager of the DuBois gas meter plant, moves to Pittsburgh as assistant to the vice-president. He will take part of the administrative load created by the four plants the division has added in recent months.

Earl Hudson, named general manager of the Porterville, Calif., plant earlier this year, succeeds Mr. Connor at DuBois.

A. A. Fomilyant will become general manager of the Porterville plant when it is completed early in 1957. In the meantime he will be in charge of the plant and remain general manager of the Tulsa, Okla., plant.

Chicago Tank Expands PC Sales

Some sales appointments have been made by Chicago Steel Tank Co. as part of its effort to expand activities in the chemical and petrochemical industries.

John P. Jennings has been named general sales manager and will be in complete charge of sales, advertising and sales promotion. He was formerly with the Nooter Corp., where he served as sales engineer.

Mr. Jennings

Mr. Maybaum

Mr. Joseph

In the field erection division, John W. Maybaum has been named sales engineer. He has had field erection experience at both Chicago Bridge & Iron Co. and Graver Tank & Manufacturing Co.

Burton M. Joseph has been named sales engineer. He will work in the field of alloy fabrication. He was formerly with American District Steam Co.

NEW SALES VICE-PRESIDENT of Mason-Neilan Division Carl Gram has been with the company since 1938, following graduation from Dartmouth with a B.S. in chemistry. He has worked in both engineering and sales. Mason-Neilan, a division of Worthington Corp., makes valves and process instruments.

Personnel Changes

Davison Chemical Co.—Charles E. Meginnis to assistant sales manager, and Robert H. Herrmann to technical service manager, of the industrial chemicals department. Both are located in Baltimore.

Babcock & Wilcox Co.—Anthony D. Zar to sales representative in charge of the Milwaukee district office of the tubular products division. Zar was with Globe Steel Tubes Co. before its purchase by B&W in 1955; Ralph R. Ryan to sales representative of the division's Detroit district.

Fritz W. Glitsch & Sons, Inc.—J. J. Tunno to manager of the New York district office. He was formerly district sales manager of the Tulsa and Cleveland branches.

Badger Manufacturing Co.—Bert R. Chenault to sales engineer and manager of the new Houston office. He was formerly a design engineer with Air Preheater Corp., a process engineer for Magnolia Petroleum Corp., and a sales engineer with Lummus Co.

Beckman Instruments, Inc.—Dr. William F. Ulrich to the application engineering staff of the Scientific Instruments Division. He will work on scientific and process instrumentation.

Worthington Corp.—J. R. Matullo to branch manager of the New Jersey sales office.

Fischer & Porter—Harold L. Russell to eastern regional manager for data reduction and automation equipment. Headquarters are in Hatboro, Pa.; William C. Abbey to southwest regional manager, also in data handling sales, with headquarters in Houston. He was a process engineer with Socony Mobil Oil Co.

Branches, Distributors

Schuyler Manufacturing Corp. has appointed Rawson & Co. sales representatives for their complete line of mist eliminators. Rawson is at 1223 Waugh Dr., Houston.

Wyatt Metal & Boiler Works has opened a sales office in Pittsburgh at 505 Grant St. L. T. Willhelm, formerly a salesman in Houston, has joined the Pittsburgh office.

INJECTOR-STICKING is the problem at hand here. In this case, a combination of Du Pont FOA-2 and Metal Deactivator proved to be the solution.

Now—a new Du Pont Service to help you solve diesel-fleet fuel problems

When a diesel operator encounters a fuel problem—such as injector-sticking or filter-plugging—he often tends to blame the refiner for his troubles. And with a big fleet operator, such complaints are likely to jeopardize a substantial amount of business. It is at this point that your customer relations can often be improved by the analysis and opinions of a third party, a Du Pont technical representative backed up by numerous Du Pont facilities.

To help you solve these problems as quickly and easily as possible, our Du Pont Petroleum Chemicals Division automotive specialists will be glad to work with your men. Their practical experience with this type of problem can be added to your own experience. And our five conveniently-located regional laboratories, as well as the main Du Pont Petroleum Laboratory, can also aid you in this work.

In cases where filter-plugging occurs—in both truck and tractor fleets—our service representatives have found that Du Pont Fuel Oil Additive No. 2 (FOA-2), or a combination of FOA-2 and Du Pont Metal Deactivator (DMD) helps overcome the trouble. This same combination of additives has proved helpful also in overcoming injector-sticking. However, since different diesel fuel stocks vary considerably in composition and response to additives, each problem must be studied on an individual basis.

Different diesel engine injector designs may also affect the performance of fuels. We are, therefore, also working with diesel engine manufacturers on injector-sticking problems.

So if you are encountering fuel problems with any of your accounts, it may pay you to discuss them with one of our automotive specialists. And you can request this service through any of our offices listed below.

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PHILADELPHIA 2—3 Penn Center Plaza ..... LOcust 8-3531
PITTSBURGH 22—Room 751, 1 Gateway Center ..... ATlantic 1-2933
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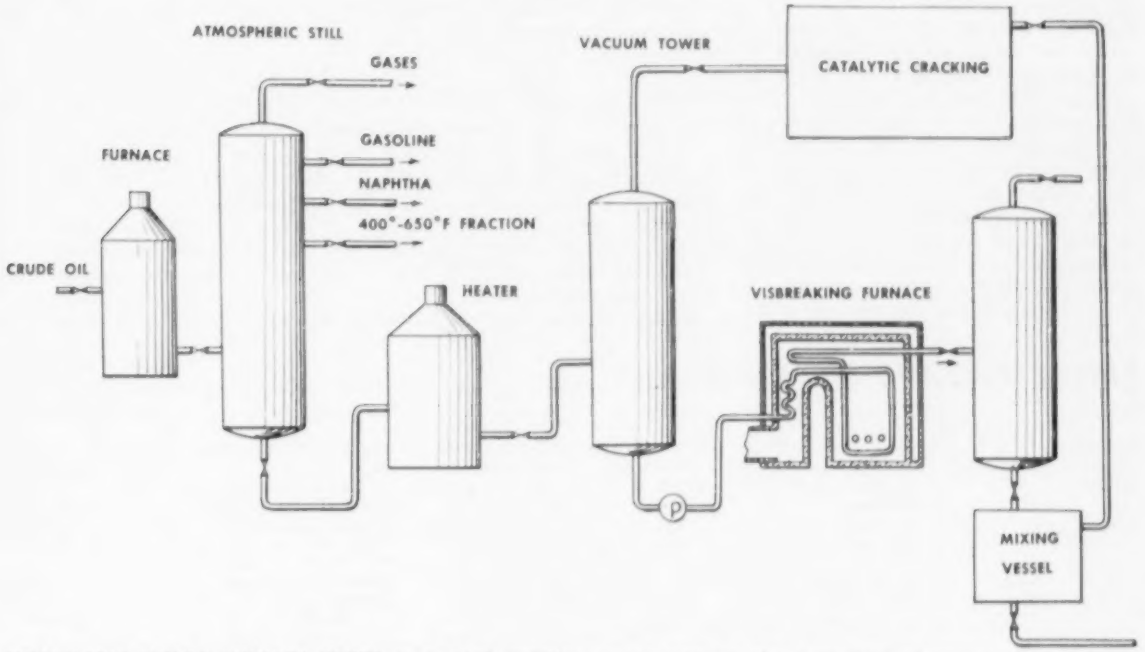
(To obtain more data on advertised products see page 182)



VISBREAKING DEEPLY REDUCED CRUDE gives high gasoline yields without the formation of excess coke and gas

Feed preparation is the secret of . . .

More Gasoline from Visbreaking

THERMAL cracking or visbreaking of conventional vacuum residuum at temperatures over 900°F has not been successful. To get the conversion wanted, a great excess of gas and coke is formed. Thus, to have a conversion to 8 vol%, or more, gasoline coke forms so fast as to make the process onstream time uneconomically short. On the other hand, to operate at temperatures not forming excess coke gives too little conversion to gasoline.

Gulf Oil Corp., in their U. S. Patent No. 2,762,754, describe a new once-through visbreaking process (apparently the basis for Gulf's new 22,500 b/d visbreaker at Philadelphia, Pa., announced in PETROLEUM PROCESSING, Oct., 1956, pg. 9) which gives a high gasoline yield without excess coke formation.

The secret of the process is feed preparation. By using a very high vacuum, or a high heat input in the vacuum distillation step, they obtain a residuum much reduced in coke-formers. Though only a theory, Gulf researchers feel that the benefit of this extra reduction of the vacuum residuum is to remove oil components largely paraffinic in nature. Apparently the paraffins not only become coke during visbreaking, but tend to direct conversion of the remainder of the feedstock into contributing to the unwanted excess.

In brief, the process takes crude oil, subjects it to conventional atmospheric distillation. The fraction boiling below 650-750°F then undergoes a vacuum distillation adjusted so as to give a bottoms product with a Conradson carbon residue of at least 18, and A.P.I. gravity below 10, and a S.U.S. (@210°F) viscosity of a least 6000.

Vacuum bottoms, exceptionally deeply reduced crude, then go to a conventional thermal cracking unit having a conversion coil in a cracking furnace. The charge outlet temperature is held to 900-1000°F, and coil operation is adjusted to give 8-20 vol% gasoline (C_4's up to 400° end point).

The Patent gives several operating examples to illustrate the process advantages, wherein the deeply reduced crude gives little, if any, coke formation over long operating periods, but where conventionally reduced crude will coke-up the coils in a very short time.

Good Jet Fuel Fractions Increased by Hydrocracking

FOR use as diesel fuels, particularly in high speed engines, oils having an API gravity of about 30-45° and boiling in the range of about 350-750°F are generally preferred. For turbo-prop and turbojet engines, good grades of kerosine are considered acceptable, except perhaps where lower freezing point requirements prevail. But increasing demands for this type of fuel cannot be met by present methods employing catalytic cracking except at the expense of distillates required for other uses, including

motor lube oil and aviation gasoline.

U. S. Patent No. 2,729,596, issued to Houdry Process Corp, discloses a method of cracking under high hydrogen pressures and with catalysts having both cracking and hydrogenating activity to obtain a highly saturated synthetic crude. Although the crude is rich in naphthenes and has a fairly high content of aromatics, it can be treated to produce high yields of good diesel and jet fuel fractions. When the boiling range of progressive cuts of the hydrocracked product is widened there was an unexpected and striking increase in normal paraffin content and a decrease in iso-paraffins A similar change upon widening the cuts is not found in liquid products from the usual catalytic cracking process.

In the process, a heavy gas-oil cut from crude is subjected to hydrogenative cracking in presence of a synthetic silica-alumina impregnated with 2% nickel at 700-900°F and 1000-3500 psi. At least 3 mols of hydrogen per mol of oil charged is added. Space velocities under 3 volumes of oil liquid per hour per volume of catalyst are preferred.

About the Patents Listed

The following patents have been selected because of their interest to the petroleum processing industries. Included in this issue are patents from the Official Gazette of the U.S. Patent Office for August 14, 21, 28, Vol. 709, No. 2, 3, 4, and September 4 and 11, Vol. 710, No. 1 and 2, 1956.

You can obtain copies of patents for 25¢ each by writing directly to the Commissioner of Patents, Washington 25, D. C.

PROCESSES AND METHODS

FOR . . .	OF . . .	WITH . . .	ASSIGNEE . . .	PATENT . . .
Addition	fresh catalyst	regenerated catalyst to fluid reactor	Houdry Process Corp.	2,760,843
	granular solids	moving-bed catalytic reactor	Sun Oil Co.	2,760,914
Alkylation	aromatic amines	olefin & aluminum	Farbenfabriken Bayer AG	2,762,845
	aromatics	Friedel-Crafts catalyst	Universal Oil Products Co.	2,759,028-30
	aromatics	selective isomers & homologs	Universal Oil Products Co.	2,761,000
	isobutane	thermally cracked naphtha—cold H_2SO_4	American Oil Co.	2,758,960
Catalytic cracking	hydrocarbons	cat. regen. to remove metals	The Texas Co.	2,760,913
Catalytic reforming	hydrocarbons	fluid-catalyst bed	Standard Oil Co. (Ind.)	2,761,820
	hydrocarbons	fluidized cat. & H_2 treat. of regen. cat.	Esso Research & Engrg. Co.	2,760,910-11
	hydrocarbons	hydrogen & platinum-alumina cat.	Esso Research & Engrg. Co.	2,761,819
	hydrocarbons	regeneration of fluidized catalyst	Esso Research & Engrg. Co.	2,762,752
	light hydrocarbons	acidic-promoted gel-type catalyst	Sinclair Refining Co.	2,759,876
	motor fuels	fluidized catalyst system	Esso Research & Engrg. Co.	2,758,959
	naphthas	nonacidic catalyst	Houdry Process Corp.	2,760,999
	naphthas	prenitrided molybdenum catalyst	Gulf Research & Development Co.	2,758,958
Chlorination	phenol	sulphur dioxide, phenol and chlorine	Columbia-Southern Chemical Corp.	2,759,981
Circulation	fluidized solids	two inter-connected vessels	Shell Development Co.	2,758,885
Coking	hydrocarbons	fluid coke particles in reactor	Sinclair Refining Co.	2,761,825
Concentration	dilute HNO_3	counter-current hot air treatment	Allied Chemical & Dye Corp.	2,761,761
Condensation	formaldehyde	pH control in catalytic system	Celanese Corp. of America	2,760,983
Connection	fluid pipes	inflatable stopper bag	R. M. Soehnlen & E. Alters	2,759,254
Contacting	liquid-solid matls.	gas in reactor contact zone	Universal Oil Products Co., Inc.	2,762,683
	liquids	automatic heat control	Phillips Petroleum Co.	2,762,761
Control	process temperature	heat control to packed column	Phillips Petroleum Co.	2,758,793
Conversion	hi-boilers	catalyst & non-carbonizable gas	Gulf Research & Development Co.	2,760,842
	hydrocarbons	dual temp. system with cat. regen.	Union Oil Co. of Calif.	2,759,878-9
	hydrocarbons	moving-pebble reactor system	Phillips Petroleum Co.	2,759,881
	hydrocarbons	combination of desulf. & cat. reforming	Esso Research & Engrg. Co.	2,760,905
	hydrocarbons	platinum & palladium cats. (& cat. mfg.)	M. W. Kellogg Co.	2,760,912 & 40
	hydrocarbons	fluid-bed catalyst system	M. W. Kellogg Co.	2,760,916
Cracking	hi-boiling oils	moving-bed solid contact material	Socony Mobil Oil Co., Inc.	2,760,915
	residues	coke particle admixture	Esso Research & Engrg. Co.	2,759,880
Decomposition	acid sludges	spent caustic	Esso Research & Engrg. Co.	2,762,759
Dehydroalkylation	aromatics	olefin using sulfuric acid catalyst	American Oil Co.	2,759,027
Desulfurization	hydrocarbons	vanadium oxide cat. & naphthenes	Esso Research & Engrg. Co.	2,760,906
Dewaxing	oils	ketone and aromatic oil solvents	Esso Research & Engrg. Co.	2,760,904
Elevation	granular matl.	gaseous lift medium	Houdry Process Corp.	2,762,658
Extraction	polynuclear aromatics	phosphoric acid-oil & BF_3	Standard Oil Co. (Ind.)	2,762,750-1
Fluorination	hydrocarbons	vapor-phase, fluid cat. process	The Texas Co.	2,759,026
Foam control	acid	recovery of dilute H_2SO_4 treat.	Esso Research & Engrg. Co.	2,762,690
Grease	lube oil	complex soap & synthetic lube oil	Esso Research & Engrg. Co.	2,758,973
Heat exchange	gas-solids	solids (catalysts) removal from gas	Esso Research & Engrg. Co.	2,762,753
	liquid	hot combustion gases	Freeport Sulphur Co.	2,759,328
Hydrocracking	hi-boiling oils	fluidized, fixed-bed reactor	Gulf Research & Development Co.	2,760,917
Hydrodesulfurization	hi-boiling oils	cobalt molybdate-type catalyst	Esso Research & Engrg. Co.	2,761,816-7
Hydrogen treating	mineral oils	H_2 & MoO_3-alumina silica gel—etc. cat.	Union Oil Co. of Calif.	2,760,907
Hydrogenation	aldehydes	in presence of cat. & added water	Gulf Research & Engrg. Co.	2,760,994
	aromatics	Ni-Mo catalyst	Shell Development Co.	2,758,957
Hydrolysis	alkyl chlorides	alkali metal hydroxide	Esso Research & Engrg. Co.	2,761,888
Inhibition	lube foams	aliphatic alcohol-formed additive	Esso Research & Engrg. Co.	2,761,845

FOR . . .	OF . . .	WITH . . .	ASSIGNEE . . .	PATENT . . .
Isomerization	satd. hydrocarbon	hydrogenation cat. & cracking inhibitor	Gulf Research & Development Co.	2,762,854
Manufacture	acrylonitrile	HCN, acetylene & activated charcoal	National Research Corp.	2,762,834
	adducts	phosphoryl amide & C_3H_6-dicarboxylic acid	Union Oil Co. of Calif.	2,760,974
	alcohols	natural gas-CO reaction	Gulf Research & Development Co.	2,759,025
	alkyl aromatics	tertiary butylbenzene & isoparaffin	California Research Corp.	2,759,984
	ammonium sulfate	continuous reactor system	C. Otto	2,759,796
	asphalt	H_3PO_4 &/or oxidation or heat treat.	Socony Mobil Oil Co., Inc.	2,762,755-758 inc.
	benzene hexachloride	purification by crystallization	Ethyl Corp.	2,760,995
	branched paraffins	heating in presence of peroxides	California Research Corp.	2,759,031
	catalyst	cat. bonded to washed bentonite clay	Union Oil Co. of Calif.	2,759,899
	catalyst	platinum on alumina	Universal Oil Products Co.	2,759,897
	catalyst	silica-magnesia having better regen.	Standard Oil Co. (Ind.)	2,760,939
	CO	oxidation of solid fuel	The Texas Co.	2,761,772
	fluorohydrocarbons	acetylenic cmpd., HF & BF_3	Universal Oil Products Co.	2,762,849
	formin	formaldehyde gas & NH_3 in aq. solv.	Josef Meissner	2,762,799-800
	fuel gas	thermal cracking of light hydrocarbons	Institute of Gas Technology	2,759,806
	H_2 & carbon	molten metal & cat. dehydrog. of gas	Houdry Process Corp.	2,760,847
	HCl & Na_2SO_4	H_2SO_4, NaCl in Na_2SO_4-H_2O soln.	Ethyl Corp.	2,762,689
	hexachloro-cyclohexane	chlorination of benzene	Food Machinery & Chemical Corp.	2,759,982
	high Btu gas	conversion of burner oil with air	Koppers Co., Inc.	2,760,853
	hydrogen	steam gasification of solid fuel	Union Oil Co. of Calif.	2,759,799
	hydrocarbons	fluidized-iron cat. of CO & H_2	Standard Oil & Gas Co.	2,762,828
	iron oxide	spherical particle shape	Universal Oil Products Co.	2,759,898
	latex	water emulsion polymerization	Phillips Petroleum Co.	2,761,853
	lube additive	phosphorus sulfide reaction prod.	Standard Oil Co. (Ind.)	2,759,920
	$(NH_4)_2SO_4 \cdot 2NH_4NO_3$	ammonia & dilute nitric acid	Bergwerksgesellschaft Hibernia AG	2,762,699
	odorless solvent	hydrofining of isoparaffin olefin alkylate	Esso Research & Engrg. Co.	2,762,853
	paraffin wax	two-stage dewaxing & slack wax comb.	Shell Development Co.	2,761,814
	phenols	benzene, water & copper sulfate	California Research Corp.	2,760,991
	reforming cat. base	alumina composition	Esso Research & Engrg. Co.	2,762,782
	reforming catalyst	zinc-alumina-molybdenum oxide	Esso Research & Engrg. Co.	2,762,783
	silicon halide	hydrocarbon compounds	Ethyl Corp.	2,762,824
	sulfur	cat. of Na/K & metal oxide & O_2	Standard Oil Co. (Ind.)	2,760,848
	vinyl chloride	pyrolysis of ethylene dichloride	Monsanto Chemical Co.	2,762,850
Oxidation	alkyl benzenes	Willgerodt reaction improvements	California Research Corp.	2,762,839
	olefins	oxygenated compound product	Stanolind Oil & Gas Co.	2,762,829
Plasticization	rubbery copolymers	organic ester	Phillips Petroleum Co.	2,760,632
Polymerization	copolymer	butadiene & acrylonitrile in emulsion	Polymer Corp., Ltd.	2,759,911
	drying oil	butadiene in org. solv. & Na	Esso Research & Engrg. Co.	2,762,851
	ethylene	liquid phase system	E. I. du Pont de Nemours & Co.	2,762,791
	diolefins	alkylene earth metal & oxide catalyst	Standard Oil Co. (Ind.)	2,762,790
	olefins	fluidized catalyst	Esso Research & Engrg. Co.	2,761,889
	olefins	liquid phosphoric acid	Esso Research & Engrg. Co.	2,759,033
Purification	hydrocarbons	molten urea extract	Esso Research & Engrg. Co.	2,762,792
Reaction	gases	catalyst from Co or Ni group	United Gas Improvement Co.	2,759,805
	hydrocarbons	vapor phase & light radiation	Esso Research & Engrg. Co.	2,762,768
	liquids	continuous heat addition or removal	Shell Development Co.	2,762,682
Recovery	alcohols	C_7-C_8 carboxylic acid salt soln.	Stanolind Oil & Gas Co.	2,762,830
	dewaxing aid	aromatic hydrocarbon from slack waxes	Phillips Petroleum Co.	2,760,996
	ethanolamines	aliphatic alcohol extraction	Tidewater Oil Company	2,761,818
	hydrocarbons	absorption from natural gas	Jefferson Lake Sulphur Co.	2,759,560
	sulfur	oxidation of hydrogen sulfide	Stanolind Oil & Gas Co.	2,758,913
	volatiles	heating of solid adsorbent	The Texas Co.	2,761,824
Refining	aromatics	neutralization of sulphuric acid	Oil and Chemicals Products, Inc.	2,761,887
	synthetic paraffins	water treat. & hydrogenation	Ruhrchemie AG	2,761,871
Regeneration	caustic alkali soln.	organic polyhydroxy cmpd. cat. & oxid.	Shell Development Co.	2,760,909
	cracking catalyst	electrostatic catalyst-gas separation	The Texas Co.	2,758,978
	extractant	oxygen & organic chemical removal	Stanolind Oil & Gas Co.	2,762,831
	solid catalyst	compressed atmospheric air	Esso Research & Engrg. Co.	2,758,979
Removal	ash-formers	water treat. of gas oil cracking feed	Esso Research & Engrg. Co.	2,761,821
	copper in mineral oil	metal acetate treatment	Sun Oil Co.	2,759,875
	mercaptans in gaso.	caustic soda-sodium plumbite treat.	Compagnie Francaise de Raffinage	2,759,874

FOR . . .	OF . . .	WITH . . .	ASSIGNEE . . .	PATENT . . .
Resins	petroleum	aluminum halide polymerization catalyst	Esso Research & Engrg. Co.	2,758,988
Separation	acetylene	solvent extraction system	Monsanto Chemical Co.	2,762,453
	alkyl sulfides	cuprous chloride impregnated adsorbent	Phillips Petroleum Co.	2,760,908
	carbon black	electrostatic de-agglomeration	Phillips Petroleum Co.	2,758,666
	catalyst fines	electrostatic separator	Sinclair Refining Co.	2,759,877
	cyclo cmpds	thiourea adduct in hydrocarbon mixture	Sinclair Refining Co.	2,759,917
	emulsions	filtration	Shell Development Co.	2,758,720
	gases	sep. of deuterium hydride from N_2 & H_2	Phillips Petroleum Co.	2,760,352
	gases from liquids	vacuum system	American Viscose Corp.	2,758,910
	HCN from gases	adsorption in column	Union Oil Co. of Calif.	2,759,797
	HF catalyst	distillation and heating	Phillips Petroleum Co.	2,759,032
	hydrogen sulfide	counter-current adsorption	Universal Oil Products Co.	2,761,755
	hydrocarbons	absorption giving gaso and lube oil	Esso Research & Engrg. Co.	2,762,852
	hydrocarbons	crystalline urea complexes, etc.	Socony Mobil Oil Co., Inc	2,759,915-6; 918-9
	liq. hydrocarbons	activated carbon	Pure Oil Co.	2,761,822
	oil from water	air flow through sump	Esso Research & Engrg. Co.	2,759,608
	oil impurities	flotation gas & ester	Union Oil Co. of Calif.	2,759,607
	organic sulfurs	silica gel adsorption of gases	Chemical Construction Corp.	2,762,452
	pour compounds	phosphoric acid amine treat. of hydrocarbons	Houdry Process Corp.	2,758,956
	phenol-mixtures	extractive-azeotropic dist.	Monsanto Chemical Co.	2,762,760
	vapor & resid. liq.	flash vaporization in baffle-tank	Phillips Petroleum Co.	2,760,918
Stabilizing	clays	substituted NH_4+ contact	Gulf Research & Development Co.	2,761,835-843 inc.
Sweetening	hydrocarbons	raw clay prior to copper sweetening	British Petroleum Co. Ltd.	2,759,873
Thermal cracking	residuum	feed preparation system	Gulf Oil Corp.	2,762,754

PRODUCTS

Asphalt	bitumen	oil-soluble tertiary amine	Standard Oil Co. (Ind.)	2,759,839
	bitumen	reaction prod. of polyamine & fatty acid	Standard Oil Co. (Ind.)	2,759,840
	mineral aggregate	bitumen plus additive	Standard Oil Co. (Ind.)	2,759,841
	petroleum asphalt	alcohol and/or metal oxide aerogel	Standard Oil Co. (Ind.)	2,759,842-3
Aviation gasoline	normal hexane	iso-hexane, HF hvy. alky., hvy. naph. & TEL	Phillips Petroleum Co.	2,761,770
Catalyst	platinum	inert carrier & Al_2F_3 & Al-Boro fluoride	Shell Development Co.	2,762,781
Ductile asphalt	asphaltic matl.	soft wax & petroleum resins	Pure Oil Co.	2,761,823
Extreme press. lube	lube oil	naphthenic lead soap and carboxylic acids	Standard Oil Co. (Ind.)	2,759,893
Fuel oil	SR distillate fuel	cracked dist. fuel & a Ca salt cond. prod.	Gulf Research & Development Co.	2,760,852
Gasoline	mixture	1-10% unsaturated amine	Phillips Petroleum Co.	2,758,916
Hi-temp lube	powdered graphite	bentonite & sebacate cmpds.	Gulf Research & Development Co.	2,761,844
Hydraulic fluid	condensation prod.	ethylene oxide & fatty acid	Atlas Powder Co.	2,758,796
Inhibition	corrosion	ferric oxide & alkali metal ferrites	Pure Oil Co.	2,761,765
	corrosion	thickened lube oil product	Esso Research & Engrg. Co.	2,758,981
Lube additive	lube oil	cmpd. of $(RO)_2(P{-}S)\text{-}S\text{-}S\text{-}CCl_3$	Esso Research & Engrg. Co.	2,760,937
Lubricant	diester	tricresyl phosphate & sulfonic acid soap	Esso Research & Engrg. Co.	2,760,934
	lube oil	Ca salt of partial ester of 1-hydroxy-phosphonic acid	Esso Research & Engrg. Co.	2,758,971
	lube oil	metal salt of naphthenoyloxy-propionic acid	Gulf Research & Development Co.	2,760,935
	lube oil	sulfide, sulfonate and alcohol additives	Esso Research & Engrg. Co.	2,758,972
	mineral oil	CO_2-Ba-2,4-diakyl phenate react. prod.	Monsanto Chemical Co.	2,762,773
	oleaginous liquid	synergistic EP additive	The Texas Co.	2,758,974
	oleaginous matl.	sulfur & carboxylic ester	Standard Oil Co. (Ind.)	2,760,933
	polymeric material	pour depressant-detergent properties	Esso Research & Engineering Co.	2,762,774
	reaction prod.	phosphorus sulfide 200-650°F syn. oil	Standard Oil Co. (Ind.)	2,760,932
Mineral oil	detergency	reaction prods. of S, P, & hydrocarbons	Esso Research & Engrg. Co.	2,759,892
Paraffin wax	polyethylene	crystalline paraffin wax	Sinclair Refining Co.	2,761,851
Rubber	polycyclic alcohol	rubber-like, vulcanizable elastomer	Phillips Petroleum Co.	2,760,946
Rust inhibitor	lube oil	reaction prods. organic Cl and CH_x-cmpd.	Esso Research & Engrg. Co.	2,759,894
Synthetic lube	organic carbonates	tricresyl phosphate	Esso Research & Engrg. Co.	2,758,975

EQUIPMENT

FOR . . .	OF . . .	WITH . . .	ASSIGNEE . . .	PATENT . . .
Adsorption	vapors	adsorbent in two-part vessel	Union Carbide & Carbon Corp.	2,760,594
Alkylation	hydrocarbons	horiz. tank with mixing compartments	Lummus Co.	2,760,850
Burning	waste gases	flare stack	Esso Research & Engrg. Co.	2,761,496
Catalytic Reactor	vertical chamber	fluidized catalyst bed	Gulf Research & Development Co.	2,761,769
Coking	hydrocarbons	solar energy heat source	R. B. Olsen	2,760,920
Combustion	gases	furnace having gas flow restriction	Universal Oil Products Co.	2,762,322
Contacting	gases & liquids	multi-chimney contact plate	W. Kittel	2,759,720
	immiscible liqs.	column with slots and baffles	Phillips Petroleum Co.	2,759,800
	immiscible liqs.	tower with mixing & settling zones	Shell Development Co.	2,759,872
	solid-liquid	counter-current apparatus	Esso Research & Engrg. Co.	2,762,692
Control	liquid level	differential pressure system	Farbenfabriken Bayer AG	2,762,390
Control	chemical reactions	thermo-responsive element	W. J. Cotton	2,758,475
Cracking	hydrocarbons	moving-bed pebbles in vertical vessel	Phillips Petroleum Co.	2,760,851
Detection	solid in gases	meas. of impingment on microphone	Tidewater Oil Co.	2,760,184
Elevation	granular solids	fluid lift medium	Houdry Process Corp.	2,758,882-3-4
	granular solids	fluid lift medium	Sun Oil Co.	2,758,881
Filter adhesive	oil	wax and polyethylene	Calif. Research Corp.	2,762,775
Heat exchange	compressed gas	rotating turbine in exchanger	Jendrassik Developments Ltd.	2,759,660
	fluids	exchanger having special tube sheet	The Pfaudler Co.	2,762,611
	fluids	moving pebbles in vessel	Phillips Petroleum Co.	2,762,693
	fluids	plurality of vertical tubes in vessel	Waagner-Biro AG	2,761,526
	vapor-liquid	vapor generating apparatus	Foster Wheeler Corp.	2,762,345
Indication	liq. level & temp.	float & reservoir system	Sun Oil Co.	2,760,373
Manufacture	heat exchangers	flat tubes and tube sheets	Olin Mathieson Chemical Corp.	2,759,247
Measurement	dew point	mirror containing tube	Phillips Petroleum Co.	2,758,470
	gas flow	submerged weir & liq. level drop meas.	Esso Research & Engrg. Co.	2,758,473
	pressure	tensioned strand & free-hanging weight	Celanese Corp. of America	2,761,317
	water in crude oil	differential pressure system	Shell Development Co.	2,758,477
Mixing	fluids	stirred vessel with jet agitation	Esso Research & Engrg. Co.	2,759,711
Pressure relief	liquids tank	depressuring valve	Phillips Petroleum Co.	2,760,343

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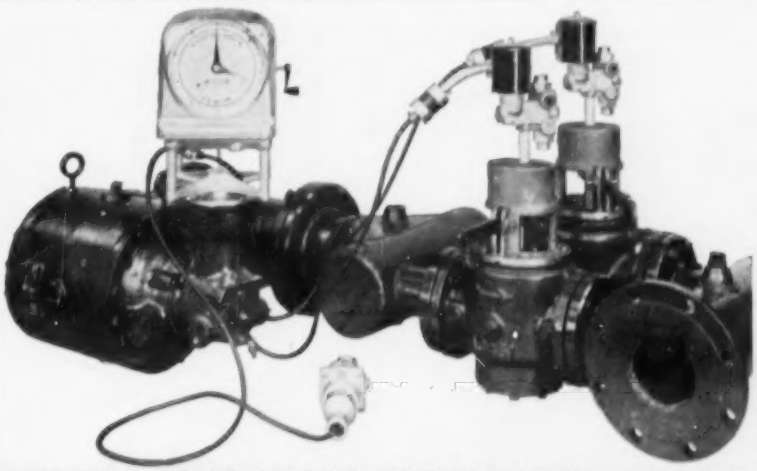

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Refining Session at Maintenance Show

MAINTENANCE in petroleum refineries and chemical plants will get a session apiece at the 1957 Plant Maintenance and Engineering Conference. The Conference will be held at the Statler Hotel, Cleveland, from January 28 to 30. The concurrent show, at the Public Auditorium, runs from January 28 to 31.

The session on maintenance in refineries will take up the following topics: planning and scheduling shutdowns; week-end maintenance work and its personnel problems; how far can preventive maintenance be used?; with what kinds of equipment should breakdown equipment be used?; special electrical problems; how much duplicate or standby equipment?; are production and maintenance jobs interchangeable?; special problems in product plants with printing, cutting, corrugating and other kinds of equipment.

In the session on chemical plants there will be discussion of: scheduling the work; determining priorities; equipment classification, groupings, and inspection routines; kinds of stores to be carried; preventive maintenance vs. over-maintenance; problems encountered in maintaining specific kinds of equipment (drying, centrifugal, compressing, etc.); salvage (of steel, pipe fittings, valves, etc.); new developments in corrosion prevention and control.

Among the other sessions at the conference, these should be of special interest to the petroleum refiner:

January 28, 1957
Morning Session
"The Changing Requirements for Maintenance"
Evening (Concurrent)
"Preventive Maintenance—A Case Report"
"Maintenance Cost Controls"
"Maintenance Shops"
"Maintaining Handling Equipment"
"Painting"
"Equipment Replacement Policies"
"Labor Relations Where Union Labor Is Employed"
"Maintenance of Equipment Standards"
"Maintaining Electrical Distribution Equipment"
"Lubrication"

January 29, 1957
Morning (Concurrent)
"Organization—A Case Report"
"Yardsticks by Which to Measure the Effectiveness of Maintenance"
"Training and Education for Maintenance Personnel"
"Maintenance in Small Plants (50 or fewer maintenance employes)"
"Maintenance Welding"
Afternoon (Concurrent)
"Getting Maintenance People to Work as a Team"
"Maintenance in Continuous-Operation Plants"
"Sanitation with Particular Reference to Floors, Windows, and Washrooms"
"Maintenance of Electrical Rotating Equipment and Controls"
"Planning and Scheduling—A Case Report"

The concurrent sessions will be repeated on January 30.

The Show is expected to exhibit 5000 pieces of equipment and accessory products, grouped in 278 categories. Number of exhibitors is expected to exceed 400 and the net space used for exhibits alone should total over 100,000 sq ft.

API Annual to Have Session on Weather

The first session to be sponsored by the Advisory Committee on Fundamental Research on Weather Forecasting will be a feature of the American Petroleum Institute's annual meeting, November 12-15, in Chicago. Since its formation two years ago, the group has been quietly investigating the state of research into long-range forecasting, and this first session will attempt to bring oil men up to date.

Papers to be offered at the Nov. 12 session are as follows:

"Importance and Need for Degree-Day Forecasting in the Petroleum Industry," by W. J. Sweeney, Esso Research & Engineering Co.

"Weather Information Applied to Fuel Supply Planning," by Charles Pennypacker Smith, Pacific Gas & Electric Co.

"The Weather Bureau's 30-Day Outlooks," by William Klein, U. S. Weather Bureau.

"Persistence and Typical Weather Patterns," by Archie M. Kahan, Texas A. & M. Research Foundation.

"The Sun's Influence on Weather Pattern Changes," by Walter Orr Roberts, University of Colorado.

"Prospects for Reliability in Long-Range Forecasting," by Hurd C. Willett, M. I. T.

"Summary of Activities, Findings,

Oil Man's Calendar

(Boldface items reviewed in this issue)

NOVEMBER
1-2 Society of Automotive Engineers, diesel engine meeting, Drake Hotel, Chicago
8-9 Society of Automotive Engineers, fuels and lubricants meeting, Mayo Hotel, Tulsa
8-9 National Assn. of Corrosion Engineers, regional, Charlotte, N. C.
12-15 American Petroleum Institute, annual, Palmer House and Hilton, Chicago
15-16 National Assn. of Corrosion Engineers, north central region, Detroit
15-16 National Assn. of Corrosion Engineers, western region, Lafayette Hotel, Long Beach, Calif.
25-30 American Society of Mechanical Engineers, annual, Statler and McAlpin Hotels, New York
26-30 3rd International Automation Exposition, Coliseum, New York
27-30 9th National Chemical Exposition, American Chemical Society, Cleveland
30 Natural Gasoline Assn. of America, Panhandle-Plains regional meeting, Herring Hotel, Amarillo

DECEMBER
3 Synthetic Organic Chemical Manufacturers Assn., annual, Biltmore, New York
6-8 Southern Chemical Conference, American Chemical Society sections, Memphis
9-12 American Institute of Chemical Engineers, annual, Statler, Boston

JANUARY
21-25 American Institute of Electrical Engineers, winter general, New York
28-30 8th Plant Maintenance and Engineering Conference, Statler, Cleveland

FEBRUARY
4-8 American Society for Testing Materials, committee week, Franklin Hotel, Cleveland
8-9 Symposium on Composition of Petroleum Oils, Research Division IV on Hydrocarbon Analysis, ASTM, Jung Hotel, New Orleans
22 Natural Gasoline Assn. of America, Permian Basin regional, Scharbauer Hotel, Midland, Texas

MARCH
10-16 Nuclear Engineering and Science Congress, ASME, Philadelphia
18-21 Gas Turbine Power Conference, ASME, Sheraton-Cadillac, Detroit
25-27 Western Petroleum Refiners Assn., annual, San Antonio
27-28 Engineering Management Conference, ASME, Penn Hotel, Pittsburgh

APRIL
7-12 American Chemical Society, national, Miami
8-10 American Society of Mechanical Engineers, spring meeting, Dinkler-Tutwiler, Birmingham, Ala.
16-18 National Petroleum Assn., semi-annual, Hotel Cleveland, Cleveland
24-26 Natural Gasoline Assn. of America, annual, Rice Hotel, Houston

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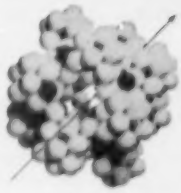

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and Goals of A.C.F.R.W.F.," by F. C. Roop, Standard Oil Co., (Ind.)

Oil Composition Symposium By ASTM Group, Feb. 8-9

A symposium on the composition of petroleum oils, especially the high-boiling fractions, will be held by a subgroup of the American Society of Testing Materials in New Orleans, February 8-9. Techniques for determining and evaluating these fractions will be taken up in the symposium, which is to be sponsored by Research Division IV on Hydrocarbons Analysis, part of the ASTM Committee D-2. The event will be held at the Jung Hotel.

Under Separation in the tentative program there will be these topics and speakers (exact paper titles have not yet been announced):

Summary of work of the API Project 6 on the hydrocarbons in the C_{18} to C_{38} portion of petroleum: B. J. Mair and F. D. Rossini, Carnegie Institute of Technology.

Silica gel adsorption and other techniques employed in the determination of the paraffin, mono and dicyclic content of a 310 to 410°C Kuwait gas oil: H. C. Rampton, British Petroleum Co.

The composition of an East Texas distillate, after hydro-generation and furfural extraction employing distillation and chromatography, followed by analysis by high mass spectrometry: B. A. Orkin, Socony Mobil Oil Co.

New thermal diffusion techniques applicable to the separation of high-boiling petroleum fractions: A. L. Jones, Standard Oil Co. (Ohio).

Separation of high-boiling oils by thermal diffusion: F. W. Melpolder, Atlantic Refining Co.

Solvent extraction and solution behavior. The application of correlations as supplement in the analysis of oil fractions: E. L. Derr, Shell Development Co.

The following are listed under Spectroscopic Methods:

The determination of methyl and methylene groups—discussion of techniques employed for the determination of total aromatic contents of petroleum fractions: R. H. Hughes, Gulf Research & Development Co.

Mass spectrometric methods of studying high-boiling oils: M. J. O'Neal and W. A. Bailey, Jr., Shell Oil Co.

Nuclear magnetic resonance characterization of petroleum: R. B. Williams, Humble Oil & Refining Co.

Influence of intermolecular interactions of nuclear magnetic resonance chemical shift measurements as related in certain high molecular weight hydrocarbon systems: J. R. Zimmerman, Magnolia Petroleum Co.

The next section is General Methods and Correlations:

Sulfonation—desulfonation and inspection of the hydrocarbon nuclei by elementary analyses, infrared and ultraviolet techniques before and after extensive hydrogenation: J. O. Knoblock, Standard Oil Co. (Ind.)

A comparison of carbon type composition of a number of oil fractions as de-

termined by a detailed method and the various short-cut correlative methods: S. S. Kurtz, Jr., Sun Oil Co.

Review and comparison of data by NMR, MS and NDM (with modifications) procedures: S. H. Hastings, Humble Oil & Refining Co.

Significance of molecular weight, discussion of methods and their application to high molecular weight stocks, limitation and evaluation of methods: F. H. Stross, Shell Development Co.

Correlative methods for structure of solid saturated hydrocarbons employing a new concept for the relationship between viscosity and chain length: G. G. Rumberger, Marathon Corp.

Cleveland to See ACS 9th Chemical Exposition

Symposia on standardizing chemical processing equipment, and plant and laboratory safety will highlight the ninth National Chemical Exposition, to be held in Cleveland's Public Auditorium, November 27-30.

The symposia will be sponsored by the Manufacturing Chemists Association. The first symposium, on chemical processing equipment standardization, will have as speakers and members D. C. Brand, Monsanto Chemical Co.; J. R. Boyer, Du Pont Co.; A. H. Knoll, Proctor & Gamble Co.; and Peter Jandrisevits, Merck & Co. Moderator will be J. G. Henderson, Carbide and Carbon Chemicals.

The discussion on plant and laboratory safety will present these people as speakers: S. M. MacCutcheon, Dow Chemical Co.; D. W. Richmond, Monsanto Chemical Co.; Howard Fawcett, General Electric Co.; and Norman White, Shell Chemical Corp.

The two Industrial & Engineering Chemical Lectures will be on "Recent Trends in the Development and Design of Chemical Processing Equipment," given by David Pearce, Diamond Alkali Co., and "Highlights of the 1956 Developments in Instrumentation," given by Ralph H. Mueller, Los Alamos Scientific Laboratory.

Clinics on Automation at 3rd Exposition, Nov. 26-30

Clinics in eight basic fields of automation will be offered at the Third International Automation Exposition, to be held in New York City's new coliseum, in Columbus Circle, Nov. 26 to 30.

A $10 registration fee entitles one to attend six sessions in any of the following basic fields:

Electronic computers, process automation, machine tool automation, office automation, automatic materials handling (conveyors), servomechanisms, electromechanical components, and electronic components.

Since "way back when," Monsanto has been helping lube manufacturers like you with the chemical problems of petroleum additives.

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 (To obtain more data on advertised products see page 182)

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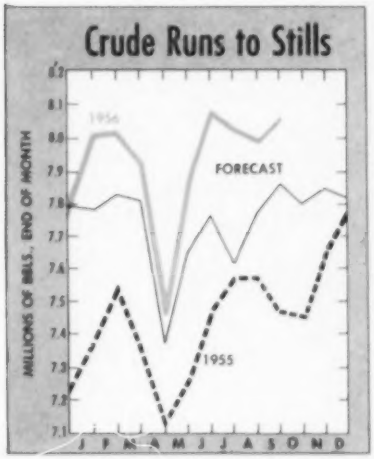
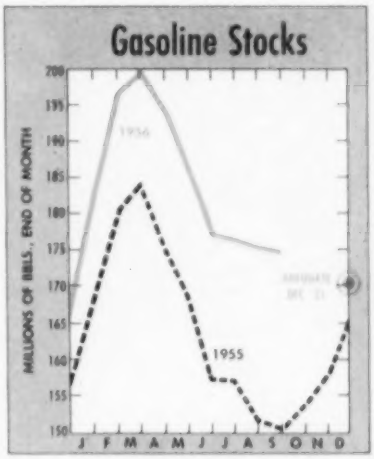
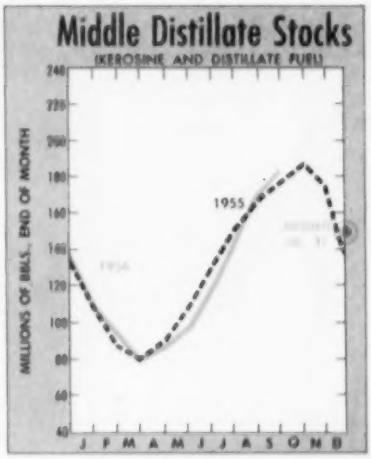






High Yields Boost "Gas" Stocks

AT THEIR current high level, gasoline inventories will be an immediate problem for refiners in the coming winter months. They also emphasize the imbalance in supply-demand of the refiners' two major products, gasoline and distillate fuel oil.

For the U.S., these inventories Sept. 28 totaled 174,720,000 bbl, 23,454,000 bbl (15.5%) higher than Sept. 30, 1955. They represented 45 days' supply of estimated fourth quarter demand, compared with 40 days last year. There has been some reduction in runs to stills the last few weeks. However, an early cold winter will have a tendency to increase runs again and accelerate the buildup in gasoline inventories.

From the long range point of view, another factor is to be considered.

OUTLOOK: Gasoline stocks may reach 190,000,000 bbl by December 31.

The present heavy gasoline stocks result in part at least from the larger relative growth, the past few years, of distillate fuel oil demand compared with gasoline demand. Total gasoline requirements increased 33% from 1950 to 1955; during the same period, distillate fuel oil demand gained over 48%. In 1950 distillate demand was 40% of gasoline requirements; in 1955, between 44 and 45%. For 9 months of 1956, gasoline demand is about 5% larger than last year, while distillate fuel oil demand increased 10%.

Gasoline yields, however, have not reflected the change in demand ratio. While the rate of growth in gasoline requirements has been smaller, the proportion of this product has been growing larger. Gasoline yield grew from 42.4% in 1952, to 43.9 in 1955. The additional output of gasoline from the crude processed has helped to build up gasoline inventories. Reductions in crude runs over a long period will tend to bring gasoline stocks into balance with demand needs, but this means of relief also reduces distillate fuel oil supply, which is now in line with demand needs. Adjustment in yields would seem to be the economic means of relief.

Gasoline stocks at refineries east of California Sept. 28, were 153,709,000 bbl, an increase of 22,463,000 bbl (17.1%) from Sept. 30, 1955. Largest surplus is in the East Coast refining district; lowest in California (see table, p. 179).

SEPTEMBER KEY STATISTICS

(Figures given in terms of millions of b/d, monthly averages, except stocks, which are in millions of bbl at end of month)

	Sept. 1956	Aug. 1956	Sept. 1955
CRUDE OIL			
U. S. Production	7.047	7.106	6.731
Imports	1.042	.951	.829
U. S. Stocks	278.415	278.461	256.269
Runs to Stills	8.030	7.994	7.483
GASOLINE			
Refinery Output	3.931	3.947	3.693
Refinery Demand	4.052	4.099	3.877
Primary Stocks	175.086	175.571	150.194
MIDDLE DISTILLATES			
Refinery Output	2.151	2.143	1.900
Refinery Demand	1.698	1.346	1.566
Primary Stocks	194.430	170.850	179.609
RESIDUALS			
Refinery Output	1.103	1.122	1.061
Imports & Other	.423	.387	.315
Total Supply	1.526	1.509	1.376
Refinery Demand	1.504	1.419	1.350
Primary Stocks	47.441	46.783	45.267

PRODUCT AND CRUDE PRICES

(Products—¢ gal, weighted average prices in principal refinery markets
Crudes—$/bbl, principal fields
Source—Platt's Oilgram Price Service)

	Sept. 1956	Aug. 1956	Sept. 1955
Gasoline (regular)	12.00	12.04	11.78
Distillate Fuel Oil	9.31	9.28	8.90
Kerosine	10.93	10.89	10.40
Residuals	5.26	5.26	4.75
Above 4 Products	9.52	9.53	9.17
Lube Oils	22.86	22.85	18.04
Crude	2.84	2.84	2.82

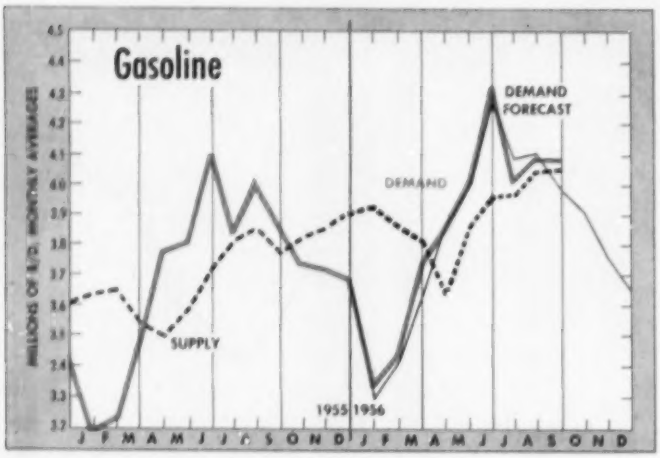
REFINERY YIELDS

% on Crude Runs to Stills

	Sept. 1956	Aug. 1956	Sept. 1955
Gasoline	44.4	45.0	44.7
Kerosine	4.1	3.9	3.7
Distillate	22.6	22.9	21.7
Residuals	13.7	14.0	14.2

SOURCE OF DATA (except prices): Aug. and Sept., API weekly reports; earlier months, Bureau of Mines

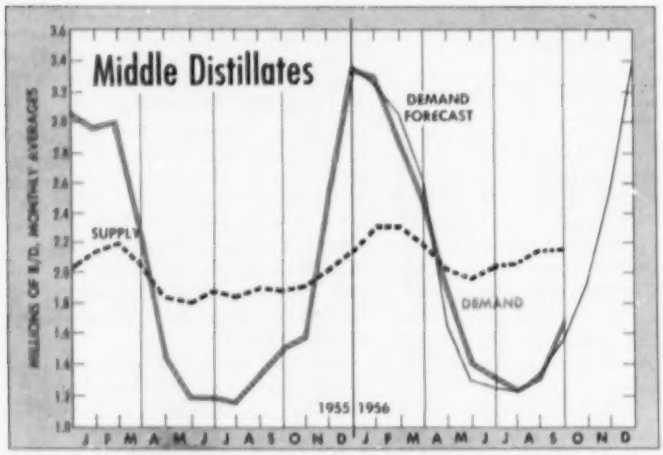
Gasoline Output Resists Seasonal Drop



MOTOR FUEL

	From Crude	From Nat. Gas	Total
SUPPLY (Millions of b/d)			
Sept. '56	3.563	.473	4.036
Sept. '55	3.342	.442	3.784
Change	+ .221	+ .031	+ .252
% Change	+ 6.6	+ 7.0	+ 6.7
DEMAND (including Exports) (Millions of b/d)			
Sept. '56			4.052
Sept. '55			3.877
Change			+ .175
% Change			+ 4.5
TOTAL SUPPLY (Millions of bbl)			
9 Mos. '56	949.373	120.696	1,070.069
9 Mos. '55	890.302	114.949	1,005.251
Change	+ 59.071	+ 5.747	+ 65.818
% Change	+ 6.6	+ 5.0	+ 6.5
TOTAL DEMAND (including Exports) (Millions of bbl)			
9 Mos. '56			1,064.410
9 Mos. '55			1,014.264
Change			+ 50.146
% Change			+ 4.9

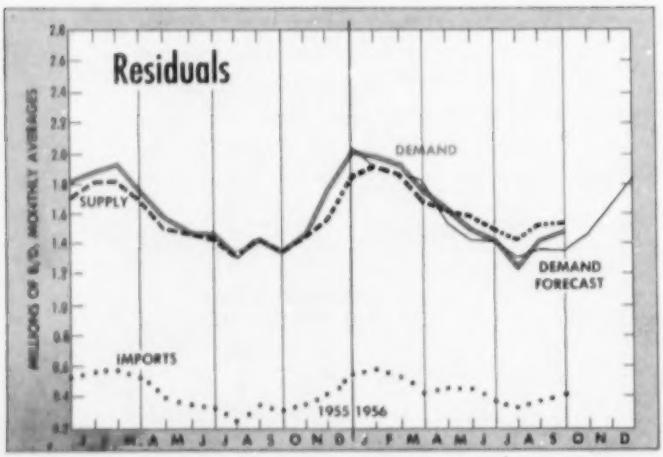
Distillate Demand Responds to Cool Fall



MIDDLE DISTILLATES

	Kerosine	Dist. Fuel Oil	Total
PRODUCTION (Millions of b/d)			
Sept. '56	.333	1.818	2.151
Sept. '55	.279	1.621	1.900
Change	+ .054	+ .197	+ .251
% Change	+ 19.4	+ 12.2	+ 13.2
DEMAND (including Exports) (Millions of b/d)			
Sept. '56	.291	1.407	1.698
Sept. '55	.244	1.322	1.566
Change	+ .047	+ .085	+ .132
% Change	+ 19.3	+ 6.4	+ 8.4
TOTAL PRODUCTION (Millions of bbl)			
9 Mos. '56	89.253	493.067	532.320
9 Mos. '55	87.052	448.076	535.128
Change	+ 2.201	+ 44.991	+ 47.192
% Change	+ 2.5	+ 10.0	+ 8.8
TOTAL DEMAND (including Exports) Millions of bbl)			
9 Mos. '56	83.833	459.058	542.891
9 Mos. '55	78.517	417.151	495.668
Change	+ 5.316	+ 41.907	+ 47.223
% Change	+ 6.8	+ 10.0	+ 9.5

Moderate Gain in Residual Fuel Shipments



RESIDUAL FUELS

	Refinery Output	Imports & Other	Total
SUPPLY (Millions of b/d)			
Sept. '56	1.103	.423	1.526
Sept. '55	1.061	.315	1.376
Change	+ .042	+ .108	+ .150
% Change	+ 4.0	+ 34.3	+ 10.9
DEMAND (including Exports) (Millions of b/d)			
Sept. '56			1.504
Sept. '55			1.350
Change			+ .154
% Change			+ 11.4
TOTAL SUPPLY (Millions of bbl)			
9 Mos. '56	319.930	124.922	444.852
9 Mos. '55	309.219	114.417	423.636
Change	+ 10.711	+ 10.505	+ 21.216
% Change	+ 3.5	+ 9.2	+ 5.0
TOTAL DEMAND (including Exports) (Millions of bbl)			
9 Mos. '56			436.632
9 Mos. '55			429.474
Change			7.158
% Change			+ 1.7

SOURCE OF DATA: Aug. and Sept., API weekly reports; earlier months, Bureau of Mines (1956 figures for 366 days)

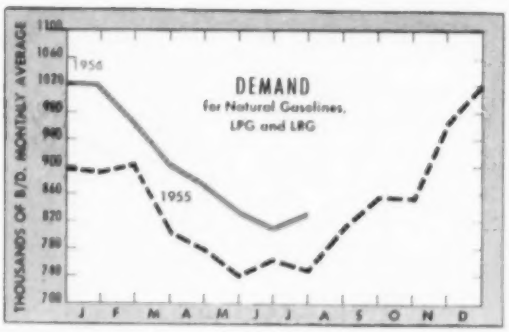
RUNS TO STILLS AND DISTRIBUTION OF PRIMARY STOCKS BY U. S. REFINERY DISTRICTS

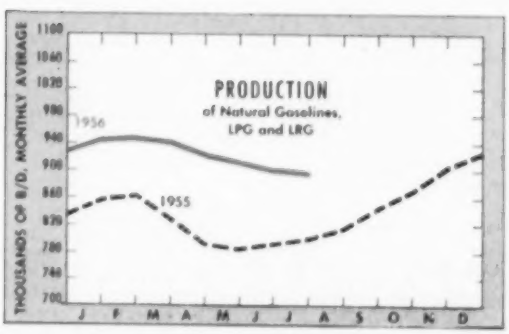
(Primary stocks include those at refineries, at large terminals and in pipelines; all data based on API reports)

District	RUNS TO STILLS (Millions of b/d average for week ending on date shown) Sept. 28 1956	Sept. 30 1955	Change	% Change	GASOLINE STOCKS (Millions of bbl, on date shown) Sept. 28 1956	Sept. 30 1955	Change	% Change	RESIDUAL STOCKS (Millions of bbl, on date shown) Sept. 28 1956	Sept. 30 1955	Change	% Change
East Coast	1.129	1.107	+ .022	+ 2.0	43.104	34.548	+ 8.556	+24.8	12.206	13.444	— 1.238	— 9.2
Gulf Coast	2.595	2.458	+ .137	+ 5.6	33.057	29.336	+ 3.721	+12.7	8.775	8.586	+ .189	+ 2.2
Total Coastal	3.724	3.565	+ .159	+ 4.5	76.161	63.884	+12.277	+19.2	20.981	22.030	— 1.049	— 4.8
Appalachian	.185	.185	0	0	7.554	6.500	+ 1.054	+16.2	.969	.982	— .013	— 1.3
Ind.-Ill.-Ky.	1.485	1.318	+ .167	+12.7	34.603	30.373	+ 4.230	+13.9	5.517	4.810	+ .707	+14.7
Okla.-Kans.-Mo.	.711	.654	+ .057	+ 8.7	17.956	15.452	+ 2.504	+16.2	1.522	1.485	+ .037	+ 2.5
Other Inland	.643	.615	+ .028	+ 4.6	17.435	15.037	+ 2.398	+15.9	2.904	2.293	+ .611	+25.6
Total Inland	3.024	2.772	+ .252	+ 9.1	77.548	67.362	+10.186	+15.1	10.912	9.570	+ 1.342	+14.0
Total East of Calif.	6.748	6.337	+ .411	+ 6.5	153.709	131.246	+22.463	+17.1	31.893	31.600	+ .293	+ 0.9
Calif.	1.149	1.125	+ .024	+ 2.1	21.011	20.020	+ .991	+ 5.0	15.606	15.154	+ .452	+ 3.0
Total U. S.	7.897	7.462	+ .435	+ 5.8	174.720	151.266	+23.454	+15.5	47.499	46.754	+ .745	+ 1.6

District	DISTILLATE FUEL OIL STOCKS (Millions of bbl on date shown) Sept. 28 1956	Sept. 30 1955	Change	% Change	KEROSINE STOCKS (Millions of bbl, on date shown) Sept. 28 1956	Sept. 30 1955	Change	% Change	TOTAL MIDDLE DISTILLATE STOCKS (Millions of bbl, on date shown) Sept. 28 1956	Sept. 30 1955	Change	% Change
East Coast	55.217	52.599	+ 2.618	+ 5.0	12.942	14.650	— 1.708	—11.7	68.159	67.249	+ .910	+ 1.4
Gulf Coast	24.947	21.652	+ 3.295	+15.2	6.323	6.261	+ .062	+ 1.0	31.270	27.913	+ 3.357	+12.0
Total Coastal	80.164	74.251	+ 5.913	+ 8.0	19.265	20.911	— 1.646	— 7.9	99.429	95.162	+ 4.267	+ 4.5
Appalachian	4.334	4.177	+ .157	+ 3.8	1.344	1.195	+ .149	+12.5	5.678	5.372	+ .306	+ 5.7
Ind.-Ill.-Ky.	26.923	28.295	— 1.372	— 4.8	8.240	9.428	— 1.188	—12.6	35.163	37.723	— 2.560	— 6.8
Okla.-Kans.-Mo.	17.703	15.517	+ 2.186	+14.1	2.891	2.571	+ .320	+12.4	20.594	18.088	+ 2.506	+13.9
Other Inland	7.588	8.288	— .700	— 8.4	1.727	1.966	— .239	—12.2	9.315	10.254	— .939	— 9.2
Total Inland	56.548	56.277	+ .271	+ 0.5	14.202	15.160	— .958	— 6.3	70.750	71.437	— .687	— 1.0
Total East of Calif.	136.712	130.528	+ 6.184	+ 4.7	33.467	36.071	— 2.604	— 7.2	170.179	166.599	+ 3.580	+ 2.1
Calif.	13.655	13.194	+ .461	+ 3.5	.350	.342	+ .008	+ 2.3	14.005	13.536	+ .469	+ 3.5
Total U. S.	150.367	143.722	+ 6.645	+ 4.6	33.817	36.413	— 2.596	— 7.1	184.184	180.135	+ 4.049	+ 2.2

Natural Gas and Refinery Gas Liquids





SUPPLY AND DEMAND STATISTICS

(Bureau of Mines Data)

CURRENT PRODUCTION (1000 b/d monthly average)	July 1956	June 1956	July 1955
At Natural Gasoline & Cycling Plants			
Liquefied Petroleum Gas	365	375	316
Natural Gasoline and Isopentane	303	302	283
Condensate	22	24	20
Finished Gasoline, Naphtha & Other	55	58	60
Total Natural Gasoline and Cycling Plant Production	745	759	679
Liquefied Refinery Gases	147	134	123
Total Marketable Gas Liquids	892	893	802
Lease Condensate	115	117	103
Total Natural Gas Liquids	1,007	1,010	906
CURRENT DEMAND (1000 b/d monthly average)			
LPG and LRG	451	427	395
Natural Gasoline, Isopentane & Other	376	379	349
Total Marketable Gas Liquids	827	806	744

CUMULATIVE PRODUCTION (1000 bbl)	July 1956	July 1955
LPG and LRG	115,752	97,606
Natural Gasoline, Isopentane and Other	80,104	75,879
Total Marketable Gas Liquids	195,856	173,485
CUMULATIVE DEMAND (1000 bbl)		
LPG and LRG	109,773	93,896
Natural Gasoline, Isopentane and Other	78,962	75,858
Total Marketable Gas Liquids	188,735	169,754

STOCKS (1000 bbl end of month)	July 1956	June 1956	July 1955
LPG and LRG	13,717	11,823	11,478
Natural Gasoline, Isopentane & Other	5,626	5,488	4,669
Total Stocks	19,343	17,311	16,147

Information Offered in the Advertisements

Do you need detailed information on a specific subject? Check through this easy-to-use index of literature and data being offered in this issue's advertisements.

BARIUM CHEMICALS, for lube oil additives, booklet; Westvaco Mineral Products Div. See adv't. p. 74.

BORON TRIFLOURIDE, catalyst, information; Baker & Adamson, General Chemical Div. See adv't. cover 3.

CATALYSTS, many types and shapes, booklet; Harshaw Chemical Co. See adv't. p. 1.

CLEANING COMPOUNDS, for process equipment, booklet; Oakite Products, Inc. See adv't. p. 194.

COMBUSTION UNITS, vertical or horizontal, bulletin 498; National Airoil Burner Co., Inc. See adv't. p. 164.

CONTRACT CONTROLLER, electronic, for measuring systems, bulletin 98265; Taylor Instrument Cos. See adv't. p. 211.

COOLING EQUIPMENT, absorption refrigerator, booklet; Carrier Corp. See adv't. p. 58.

DATA SYSTEMS, process control, data file D-2-23; Beckman Instruments, Inc. See adv't. p. 24.

ELECTRICAL EQUIPMENT, for process industries, bulletins GED-1966C & GED-2244; General Electric Co. See adv't. pp. 38-39.

EXPANSION JOINTS, catalog 56, Zallea Brothers. See adv't. p. 37.

EXPANSION JOINTS, catalog; Solar Aircraft Co. See adv't. p. 147.

FLOW CONTROL SYSTEMS, bulletin Fl-56 & J-56; Hetherington & Berner, Inc. See adv't. p. 171.

FLOW CONTROL, pneumatic flyball integrator, details; Foxboro Co. See adv't. p. 59.

FURFURAL, for solvent extraction, bulletin 203-A; Quaker Oats Co. See adv't. p. 36.

GAS CHROMATOGRAPH, booklet 83; Burrell Corp. See adv't. p. 181.

GRADIATION HEATERS, bulletin 911; Selas Corp. of America. See adv't. p. 215.

GRATING, metal, retainer for castable refractories, booklet; Klemp Metal Grating Corp. See adv't. p. 199.

HEAT EXCHANGERS, evaporative, bulletin 120; Niagara Blower Co. See adv't. p. 212.

INSULATION, glass fiber, catalog; Owens-Corning Fiberglas Corp. See adv't. p. 146.

INSULATION, asbestos, brochure IN-169A; Johns-Manville Corp. See adv't. p. 68.

INSULATION PROTECTION, asphalt base, for troweling, brochure; American Bitumuls & Asphalt Co. See adv't. p. 151.

MASS SPECTROMETER, bulletin CEC-1824B-X7; Consolidated Electrodynamics Corp. See adv't. p. 46.

MATERIALS HANDLING, side loading truck, bulletin 1360; Baker-Raulang Co. See adv't. p. 49.

METERING AND BLENDING equipment, catalogs; Bowser, Inc. See adv't. p. 200.

MIXERS, catalog series 7; Eastern Industries, Inc. See adv't. p. 64.

MIXERS, side and top entering, 8 catalogs and data sheets; Mixing Equipment Co., Inc. See adv't. p. 78.

MOLECULAR SIEVES, for adsorption, booklet; Linde Air Products Co. See adv't. p. 189.

MOTOR STARTERS, 2300-5000 volt, bulletin 1062-20; E. C. & M. Div., Square D Co. See adv't. p. 210.

PACKING, sheets, neoprene, catalogs; U. S. Gasket-Belmont Packing. See adv't. p. 19.

PIPE, saran lined, corrosion resistant, information; Dow Chemical Co. See adv't. p. 201.

PROCESS EQUIPMENT, fabrication, booklet; Newport News Shipbuilding & Drydock Co. See adv't. p. 30.

PROCESS EQUIPMENT, glassed steel and alloys, bulletins and data sheets; Pfaudler Co. See adv't. p. 207.

PROCESS EQUIPMENT, bulletin E-1; Henry Vogt Machine Co. See adv't. p. 41.

PUMPS, stuffingboxless, bulletin 107; Bingham Pump Co. See adv't. pp. 54-55.

SORPTIVE MINERALS, bauxites, clay, booklet; Minerals & Chemicals Corp. See adv't. p. 67.

STEAM TRAPS, bulletin 10-55; W. H. Nicholson & Co. See adv't. p. 176.

STEAM TRAPS, booklet and magazine; Armstrong Machine Works. See adv't. p. 72.

STEAM TRAPS, impulse type, bulletin; Yarnall-Waring Co. See adv't. p. 154.

STORAGE TRAILERS, for gas, information, Taylor-Wharton Co. See adv't. p. 199.

TANK GAUGING and control systems, remote, bulletin CP-3011; Vapor Recovery Systems Co. See adv't. p. 206.

TEMPERATURE RECORDERS, catalog; Electric Auto-Lite Co. See adv't. p. 195.

TUBE MAINTENANCE tools, bulletin 59; Airetool Mfg. Co. See adv't. p. 198.

TUBES, condenser, publication B-2; Anaconda Co. See adv't. p. 71.

TUBING, stainless, buying guide; Carpenter Steel Co. See adv't. p. 57.

UNIONS, forged, catalog 56; Catawissa Valve & Fittings Co. See adv't. p. 181.

VALVES, safety relief, bulletin; Crosby Steam Gage & Valve Co. See adv't. p. 32.

VALVES, safety relief, catalog 1900; Manning, Maxwell & Moore, Inc. See adv't. pp. 62-63.

WALKWAYS, aluminum, information; Washington Aluminum Co., Inc. See adv't. p. 181.

WIRE SCREENS, for filters and strainers, bulletins 6, 7 & 8; Cleveland Wire Cloth & Mfg. Co. See adv't. p. 195.

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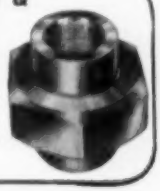

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Circle the code letter on the "Advertised Product Inquiry" card (on the page opposite) which corresponds to that assigned the advertiser about whose product you want further information.

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Wet Mix Machine

Efficiently Applies Castable Refractories

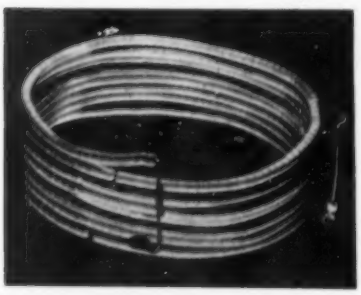
Capable of mixing and shooting a wide range of materials the Refract-All machine handles refractories containing aggregate particles of up to ¼-in diameter. It mixes the correct amount of water and material and applies the wet mixture at distances from 3 in. to 25 ft from the nozzle. Wasted material is limited to 5%.

The machine can be used for pneumatic application of castable refractories, insulation and mortar mixes. The applied material sticks to the target and builds up thick, homogeneous coatings. Thickness of the coatings can be varied from ⅛- 16 in. on vertical surfaces in a single shot application.

Density control is governed by the proportions of air used in the mixing and shooting of the charge. A standard charge of 1000 lb and 10 cu ft can be shot to the target in 1 to 3 minutes. A complete loading, mixing and shooting cycle normally requires 15 minutes for a standard charge.

The air requirements for this machine are 105 cfm of 100 psi air, which can be supplied with a separate air compressor. The Refract-All unit does not include the air compressor but does include all other required equipment pieces. **Refract-All Manufacturing Co.,** P.O. Box 338, Turley, Okla.

Circle No. **1** *on Reply Card*



Heating Coil

. . . **speeds stress relieving** of pipe welds. It can also be used for preheating.

Known as *Heat-O-Coil,* the element is a length of small diameter resistance wire, strung with ceramic ball and socket beads. Each end of the coil is formed into a small ring. After the coil is wrapped around the section of the welded pipe to be stress-relieved, the two ends are connected to the terminals of a welding machine.

Thermocouples are inserted under the coil and connected to an indicating pyrometer. Then the section is wrapped with asbestos. Necessary heat is supplied by setting the welding generator at the required amperage rate. As soon as the desired temperature is reached the generator is adjusted manually to hold the correct temperature.

The coils are available in 25-ft lengths of ⅛-in. for large diameter pipes, or in 10-ft lengths of 1/16-in. **Arcos Corporation,** 1500 South 50th St., Philadelphia 43, Pa.

Circle No. **2** *on Reply Card*

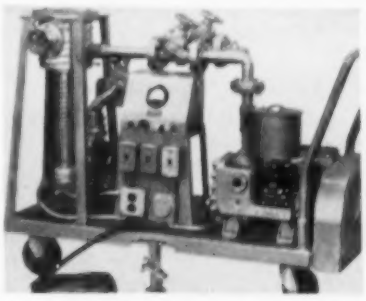
Plastic Gasket Material

. . . **prevents vacuum leaks** even after a line has been in service by applying the material to the leaking flanges.

When used before vacuum pipe is connected, the plastic gasketing is applied to the flange and gasket surfaces as a film or coating 1/64-in. thick. If applied after the line is connected, the material is put on in a greater thickness of 1/32-in., around the outside surfaces of the flanges where they meet with the gasket.

The material is available in two formulations: one for gasoline, oil and solvents; and one for air, steam, water or mild chemicals. If the flange faces are unmarred and come together evenly, this plastic material can be applied without any other type of gasketing. It is non-hardening, and flanges can be easily dismantled even after years of service. **Flexrock Co.,** 3602-T Filbert St., Philadelphia, Pa.

Circle No. **3** *on Reply Card*



Portable Vacuum Unit

. . . **produces absolute pressures** as low as 10^{-6} mm Hg for pilot plant operations and small scale production setups.

The mobile unit includes a frac-

tionating 4-in diffusion pump, connected to a 15 cfm two-stage roughing and backing mechanical vacuum pump. All components, including the electrical control panel, are mounted on a base with fixed and swivel wheels. Required service connections are a single phase, 60 cycle 110-115 volt ac outlet, and a source of cooling water.

The unit is recommended for use in exhausting 10 to 15 cu ft chambers for vacuum distillation, degassing, stress relieving and other procedures requiring high vacuum. **Kinney Mfg. Div., New York Air Brake Co.,** Boston, Mass.

Circle No. **4** *on Reply Card*

Pipe Fittings

. . . **angular branch connections** can be used for making 45° connections for directional flow and instrument connections. The "Elbolets" are available for constructing connections of welded pipe fittings requiring a full penetration weld. Typical uses are in connections into elbows for instruments, drips, and hanger and support connections. **Bonney Forge,** Allentown, Pa.

Circle No. **5** *on Reply Card*

Electric Bunsen Burner

. . . **reaches temperatures of 1470°F** within one minute after turning on, with constant control of the temperature possible by an energy regulator.

Labeled the "Burnay," the new laboratory "burner" is available with heating elements of either 340 watts or 850 watts. The source of heat is clean and odorless and eliminates the danger of explosions due to faulty gas connection. Its shape converges the infra-red rays towards its top, where lab equipment such as slides, dishes or beakers can be placed.

Available accessories permit using the "Burnray" inverted, for heating a water bath or as a hot plate. A close fitting quartz sleeve is also available for protecting the elements against spillage or boiling over. **Gardner Laboratory, Inc.,** Bethesda 14, Md.

Circle No. **6** *on Reply Card*

Drum Head Stencil Ink

. . . **dries instantly** and has good covering power. It is available in colors and is suitable for marking on metal or other non-porous surfaces. Metal drum heads can now be marked faster with this method than is possible with brushing or spraying, since the ink can be rolled on with ease. **Diagraph-Bradley Industries, Inc.** P.O. Box 269, Herrin, Ill.

Circle No. **7** *on Reply Card*

Filter Pump

. . . **is self priming** and usable on all common acids and caustic industrial solutions.

The pump assembly consists of a stainless steel pump with a neoprene impeller; a high temperature clear plastic filter chamber; a ¼-HP electric motor with switch; twenty feet of pure gum reinforced 2-ply chemical acid hose; and a movable and corrosion-proof base mounted on ball bearing rubber tire casters.

Filtering capacities vary with four available models, from 50 to 350 gph. The pump develops pressures up to 35 psi during the filtration cycle. The three #10 filter tubes contained in the plastic chamber are cotton or dynel wound around a stainless steel core. The cotton tubes are recommended for filtering most dilute acid and alkaline solutions. Dynel tubes are recommended for concentrated acids and alkaline solutions which include oxidizing acids. Particles down to 1 micron in size are removed. **Sethco Manufacturing Co.,** 70-78 Willoughby St., Brooklyn 1, N.Y.

Circle No. **8** *on Reply Card*

Pipe Insulation

. . . **withstands temperatures up to 1350°F,** and is molded in sizes to accommodate 33-in. diameter pipe.

Made of Kaytherm, a hydrous calcium silicate bonded together with asbestos fibers, the insulation is light in weight and easy to handle. It is flame-resistant, chemically inert and insoluble in water. Ordinary tools can be used to cut and install the molded insulation.

The insulation comes in a variety of thicknesses ranging from ¼ in.; lengths of the molded insulation are 36 in. and made in half-cylindrical segments. The two segments are fastened together by encircling metal bands. **Keasbey & Mattison Co., Ambler, Pa.**

Circle No. **9** *on Reply Card*

Teflon Tape

. . . **can be bonded** to almost any surface (including itself) and offers protection for chemical corrosion, electric insulation and constant abrasion.

Either or both sides of the tape are

treated by a special process which makes it readily bondable to glass, steel, aluminum, plastics and almost any other material. Satisfactory adhesives for cementing the tape to these surfaces are general purpose epoxy resin adhesives.

The cementable Teflon tape is available in continuous rolls or cut-to-size sheets. Standard thicknesses available are: 0.0005, 0.005, 0.010, 0.015, 0.020, 0.025, 0.030, 0.035, 0.040, 0.045, 0.050, and 0.060 inches. Uses for the tape are based on the low friction, unique dielectric qualities, chemical inertness, high-temperature and other characteristics of the tape material. **Enflo Corporation,** Route 38 at Airport Circle, Pennsauken, N. J.

Circle No. **10** *on Reply Card*

Electronic Thermometer

. . . has a 0.1°C accuracy up to 400°C, and 0.2°C accuracy up to 900°C. The full range of the electronic resistance thermometer is —100°C to 900°C.

To maintain this accuracy, each resistance bulb and Wheatstone bridge is individually calibrated. The vacuum sealed platinum elements and leads in the resistance bulb have a hermetically sealed head, and are supplied with either a stainless steel or quartz jacket. A plug-in controller accessory with 0.05°C reproducibility is available.

Direct temperature reading is through a Wheatstone bridge and a balanced resistor. This gives a direct reading instrument with a digital indicator. **Manostat Corp.,** 20-26 N. Moore St., New York 13, N.Y.

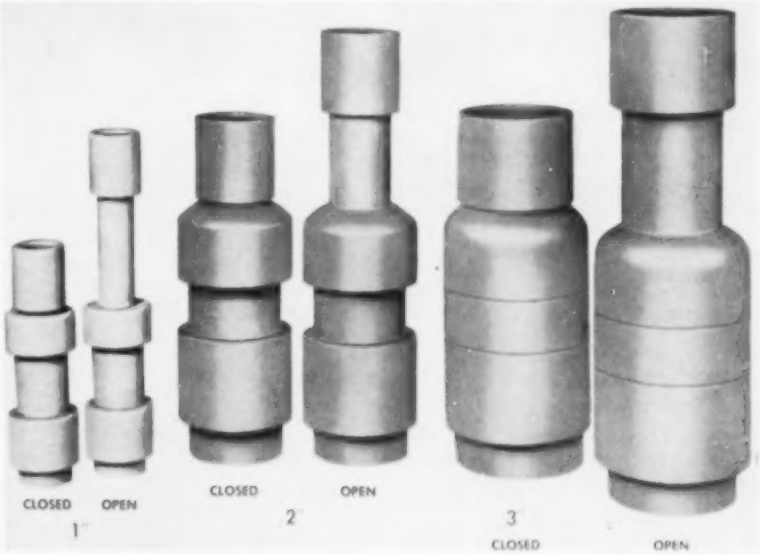
Circle No. **11** *on Reply Card*

Flo-Scope

. . . measures flow rates of air and gases and handles capacities up to 75,000 cu ft/hr of air.

Streamlined in appearance, the new design permits easy mounting on a panel and reduces the maintenance costs of cleaning. Accuracy is assured because the only moving part is not subject to wear, and each instrument is calibrated at the customer's specified flow conditions **Selas Corporation of America,** Dresher, Pa.

Circle No. **13** *on Reply Card*



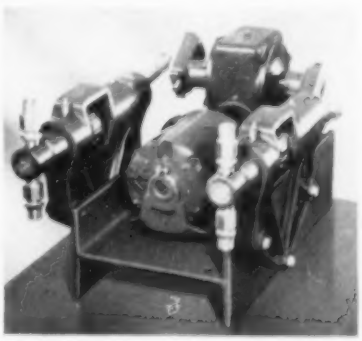
Expansion Joints

Permit Expansion in Plastic Piping

Now available are slip type expansion joints of unplasticized polyvinyl chloride, designed for use with rigidly fixed PVC piping subject to thermal cycles. Pictured above are the sizes now available. These joints may be used with smaller size pipe by employing reducing bushings. All sizes permit expansion of 3¼ in.

The joints have "O" ring packing made of neoprene and are suitable for a wide range of corrosive uses. When made of normal impact PVC, the 1-in. expansion joint has a pressure rating of 205 psi at 75°F, and of 120 psi at 75°F. The 2-in. joint is rated at 170 psi at 75°F or 100 psi at 140°F. And the 3-in. expansion joint will withstand a pressure of 150 psi at 75°F or 90 psi at 140°F. **Tube Turns Plastics, Inc.,** 2929 Magazine St., Louisville 11, Ky.

Circle No. **12** *on Reply Card*



Proportioning Pump

. . . has standardized mechanical components for easy maintenance, plus new Vane-Guide check valves which prevent the ball checks from drifting from the valve seat. The vane-guide design also contributes to smooth flow through the ball-check cylinders.

All standard models are equipped with micrometer stroke-length adjustment, with in-motion rate adjustment available if desired. This pump will handle chemical feeds from 0.8 gph to 900 gph; discharge pressures go up to 1340 psi. **Proportioneers, Inc.,** 345 Harris Ave., Providence, R. I.

Circle No. **14** *on Reply Card*

All-Position Electrode

. . . is designed for pipe welding, and is suitable for all E-6010 applications.

In pipe welding, especially on root passes with a "vertical up" technique at low currents, it is necessary to have an electrode with smooth arc operation, deep penetration and good bead wash-in. This new Fleetweld 5-P

COOPER ALLOY
CORPORATION
BRIEFS

CORED SIGMA BLADE

1500 lb. stainless steel sigma blade not only has to be corrosion resistant and dimensionally accurate, but a 1½" cored hole, centrally located with respect to the various cross sections is required throughout its length.

The full story is told in Cooper Alloy AKH #4

KEL-F LINERS FOR VANTON PUMPS

The addition of Kel-F to the long list of rubbers and plastics now available for liners makes the Vanton pump suitable for handling such media as fuming nitric and other strong oxidizing acids, mineral acids, alkalies, aliphatic solvents and hydraulic fluids.

Details on request.

STAINLESS STEEL RETARDERS

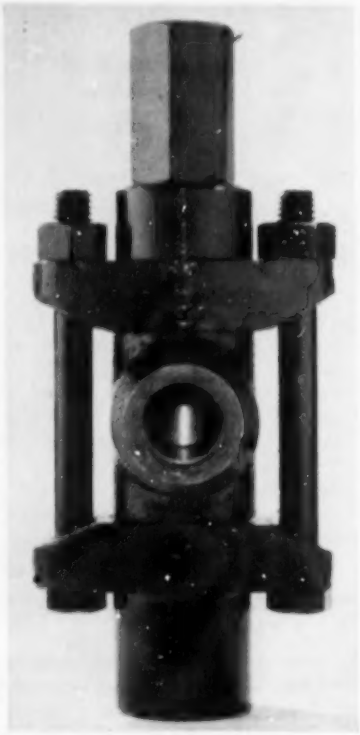
Cooper Alloy stainless steel retarders in the Cyclotherm Generator help to produce additional heat transfer with maintenance-free reliability. Known as Cyclotherm Cyclonic Combustion the new principle delivers a guaranteed 80% heat transfer in two passes and drops maintenance costs as much as 50%.

COOPER ALLOY
CORPORATION · HILLSIDE, N.J.

electrode is claimed to have all these characteristics. It also provides minimum slag interference, which permits quick freezing of the molten metal and reduces any tendency for "windows" and porosity.

The electrode conforms to AWS E-6010 requirements and is available in diameters of ⅛ and 5/32 in. Besides piping work, it is also suitable for structural welding, pressure vessels and X-ray applications. **Lincoln Electric Co.,** Cleveland 17, Ohio.

Circle No. **15** *on Reply Card*



Hi-Pressure Relief Valve

. . . **withstands 10,000 psi** and will handle a high capacity of liquid flow at 25 per cent over pressure. Designed to handle air, gas or liquid, the valve has been tested under severe field conditions.

The valve body is an extra heavy carbon steel casting. The inner parts of stainless steel are constructed so that there is no stress around the seating area, thus assuring a leak-tight seal after long periods of operation. The narrow, 45-degree seats offer less resistance to flow and less surface area to catch abrasive matter.

The valve is made in ½-, ¾-, 1- and 1¼-in. sizes, and is available in all stainless steels and alloys for petrochemical service. It is designed also for use in all systems handling crude oil, sour gas and oil vapors, including high pressure separators. **Protek Specialty Co.,** P.O. Box 194, Bellaire, Texas.

Circle No. **16** *on Reply Card*

Plastic Tanks

. . . **resist corrosion** from oxidizing acids and other chemicals which affect stainless steel. Light in weight, the tanks are made of polyester and glass reinforcement.

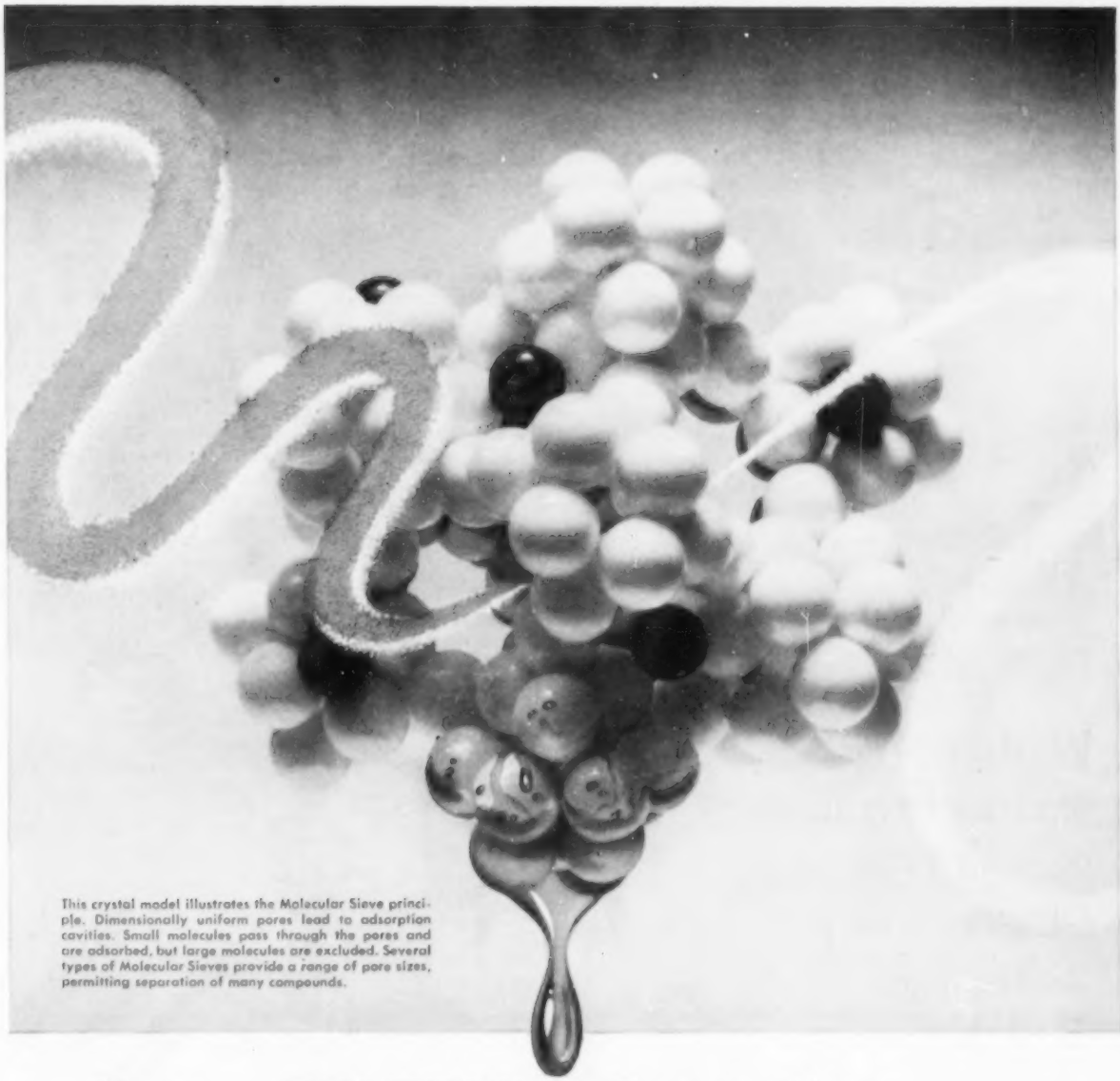
The largest tank pictured holds 600 gal but weighs only 150 lb. It can be handled by two men. Delivery of this type tank can be had promptly in either standard sizes or specially designed tanks. Cost is said to be substantially less than comparable size tanks of corrosion resistant metal. **Haveg Industries, Inc.,** 900 Greenbank Road, Wilmington, Del.

Circle No. **17** *on Reply Card*

Temperature Controller

. . . **monitors temperatures** from —200 to +3000°F, and provides a means of preventing temperatures from rising or falling past preset points.

The "Tipp-Tron" is supplied in 10 ranges of temperatures, with the



This crystal model illustrates the Molecular Sieve principle. Dimensionally uniform pores lead to adsorption cavities. Small molecules pass through the pores and are adsorbed, but large molecules are excluded. Several types of Molecular Sieves provide a range of pore sizes, permitting separation of many compounds.

Now... SELECTIVE Separation with MOLECULAR SIEVES

LINDE Molecular Sieves, a new *class* of adsorbents, offer unique performance in product purification and recovery. These crystalline zeolites provide selective separation of gas and liquid mixtures in *three* ways... difference in molecule size... or polarity... or carbon bond saturation.

Selective removal of contaminants, even in trace amounts, is possible at temperatures up to 300° F. Selective recovery of valuable stock is often accomplished without regard to relative boiling points. Co-adsorption eliminates extra processing steps by removing several impurities simultaneously. High capacity is realized through a wide range of operating conditions.

Typical uses for Molecular Sieves are the separation of n-paraffins from iso-paraffins and cyclics... extraction of olefins from refinery streams and top gases... removal of catalyst poisons from olefins... sweetening of natural gas and reformed hydrogen... purification of annealing gases.

For a descriptive booklet, "Molecular Sieves for Selective Adsorption," write Dept. PE-11, Linde Air Products Company, A Division of Union Carbide and Carbon Corporation, 30 East 42nd Street, New York 17, N. Y.

Linde TRADE MARK MOLECULAR SIEVES

The term "Linde" is a registered trade-mark of Union Carbide and Carbon Corporation

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CLEVELAND 10, OHIO

shorter one offering more precise control. Calibration is in both Fahrenheit and Centigrade. Control accuracy is held within 2% of dial settings.

Connected to thermocouples as the temperature sensing element, this contro'ler will provide a control output to meet several conditions. With on-off it initiates control action when the temperature reaches the preset limit, but continues to test the temperature periodically. If the heat reaches a permissible level, it will stop control of auxiliary equipment. And with locking control, the controller must be reset manually each time the temperature reaches the control point. **Tipp Manufacturing Co.,** Tipp City, Ohio.

Circle No. **18** *on Reply Card*

Pouring Spout

. . . **for steel or fibre drums** extends the pouring distance and permits closer control while handling material from drums.

Constructed of 10-gauge sheet steel, the Sterling pouring spout is locked onto the open top of a drum by means of a heavy locking band with fingers which grip the edge of the drum. When used with a one-man hydraulic hoist (as shown in picture) the spout permits close control when pouring dry materials or viscous fluids. **Sterling-Fleischman Co.,** Broomall, Pa.

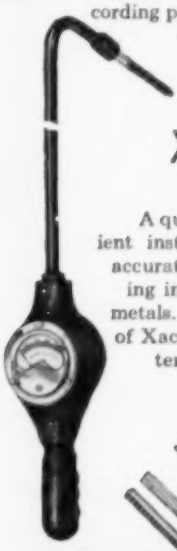
Circle No. **19** *on Reply Card*

Thread Gage

. . . **will identify** threads from 8 to 14 per inch, round or sharp, external or internal. This flat pocket gage is made from hard-surface laminated

PRECISION
TEMPERATURE
measurement
and control

GORDON
XACTLINE
Controls temperature automatically within a fraction of a degree in any heat process. A complete factory-assembled unit ready for installation anywhere. Can be used with any existing indicating or recording pyrometer controller —regardless of age.



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XACTEMP
Hand Pyrometer
A quality-built, convenient instrument for quick, accurate temperature reading in molten nonferrous metals. Also, other models of Xactemp for all-around temperature checking.

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SERV-RITE
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Insulated in Gordon's own plant to assure consistent quality.
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Brains, experience, technical skills, are all fundamental qualities in a good builder. These we have here at Procon in full measure. But, we try to add that vital touch of imagination that helps us visualize the correct answer to exacting new problems and enhances our ability to get each project completed to schedule and to every requirement.

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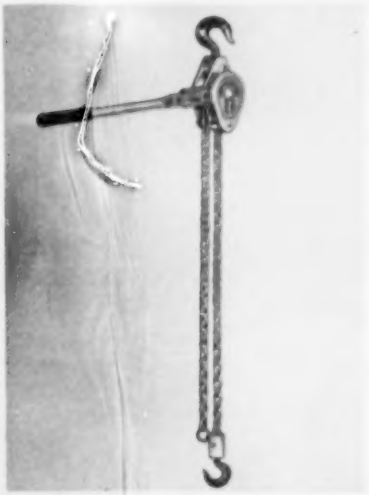
PROCON ®

(To obtain more data on advertised products see page 182)

plastic and measures only 6¼ in. long. In addition to the identification of thread sizes, the gage includes a color code identification for the manufacturer's line of Anvil Brand fittings. The gage is available free to those who write to **Pittsburgh Pipe & Coupling Co.,** Allison Park, Pa.

Circle No. **20** *on Reply Card*



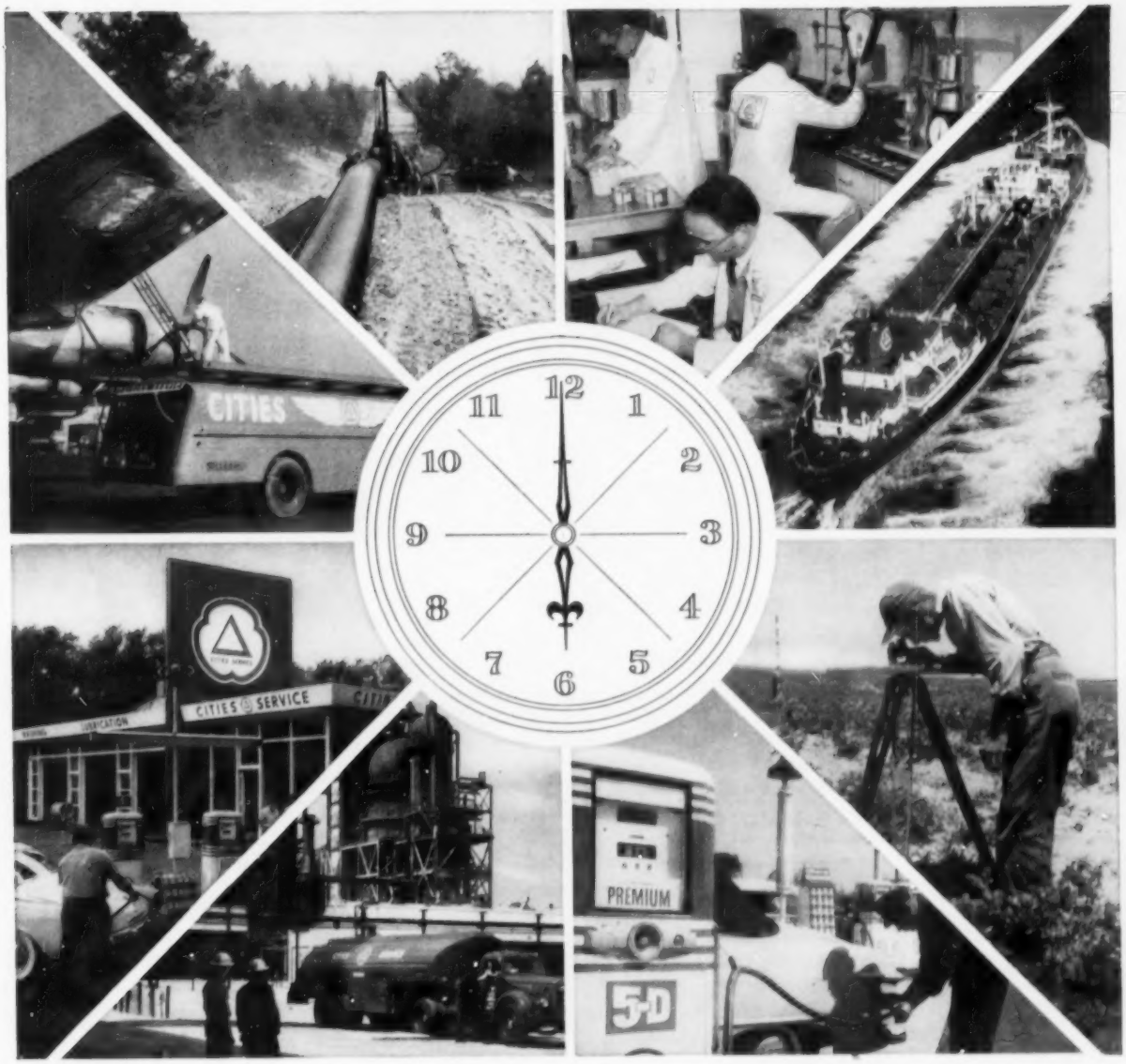
Rustproof Lever Hoist

. . . **uses only ⅓-arc movement** for operation, and is designed for angular, horizontal or vertical lifting.

The small ⅓-arc movement permits operation in tight quarters, and a special type ratchet with two ratchet levers in constant contact with the ratchet wheel keeps the wheel under control at all times. The main parts of the

"Lots of good tunes in these instrument control charts . . ."

(To obtain more data on advertised products see page 182)



A DAY

in the lives of a quarter of a million people

More than 240,000 people keep Cities Service, one of the world's largest oil companies, operating at full steam . . . 240,000 people who locate, produce, refine, improve, market and invest in the petroleum that constitutes any oil company's lifeblood.

A winning team? Judge for yourself: Today, Cities Service is pushing forward in ever longer strides, with new refining facilities and techniques, new oil discoveries, new pipelines and tankers, new dealers, and new and improved petroleum products, unsurpassed in quality.

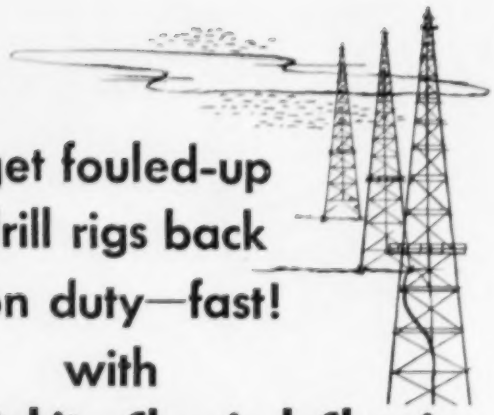
Moreover, the very fact that this surging activity exists, serves to assure further expansion . . . for healthy growth stimulates still more growth.

And significantly, this growth is more than the sign of a healthy company . . . it's living proof of a healthy country. For it again demonstrates the rich harvest of a system in which government, industry, and all citizens share an interest and an obligation toward each other.

CITIES SERVICE

Progress through Service

 (To obtain more data on advertised products see page 182)



get fouled-up drill rigs back on duty—fast! with Oakite Chemical Cleaning

Take, for instance, a bottom-hole pump brought in from the field for replacement . . . outside mucked up, insides choked with gyp.

Useless? Not if you know Oakite. A half-hour at most, and this pump can go back to work! Here's how.

A short soak in a recommended Oakite degreasing solution (Oakite 19 or 24, depending on soil), followed by pressure rinse, and everything comes off the outside. Grease, oil, paraffin, mud, rust—gone. Next, immerse in a descaling solution of Oakite 32, and now the insides are clean of all accumulated gyp and lime deposits. Rinse, then neutralize by dipping in the Oakite 19 or 24 solution. Finish by rust-proofing pump with Oakite Special Protective Oil . . . and it's ready to go.

This is just one example, out of dozens of reconditioning jobs on field equipment, where Oakite methods give you maintenance cleaning at its fastest and easiest. Call your local Oakite Technical Service Representative, or write for free booklet, "What Petroleum Men Should Know to Simplify Cleaning," to Oakite Products, Inc., 50D Rector Street, New York 6, N. Y.

SPECIALIZED INDUSTRIAL CLEANING
OAKITE
MATERIALS · METHODS · SERVICE
SCIENCE

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hoist are aluminum alloy; the chain is a brass-plated steel alloy electrically welded. Every part is rust-proof.

Top and bottom hooks swivel to permit turning of the load. Standard chain length is 64-in. but the hoist can be adapted for longer pulls by changing to a longer chain. **Thern Machine Co.**, Winona, Minn.

Circle No. **21** *on Reply Card*

Micro-Control Valve

. . . has low hysteresis in controlling pressures from 10 to 800 psi, with a minimum flow of 6 cu ft of air at 10 psi.

Special features of the small valve make it advantageous for use in laboratories and pilot plants. It has a low initial cost, a simple construction which enables easy assembly or repair with hand tools, and can be used with any standard air control instrument.

The valves, which are available in 3 sizes, have a standard body material of 304 stainless steel. Packing is of chevron ring Teflon. Only the stainless steel and Teflon are in contact with the flowing fluid. **Modern Manufacturing Co.**, Box 367 Bartlesville, Okla.

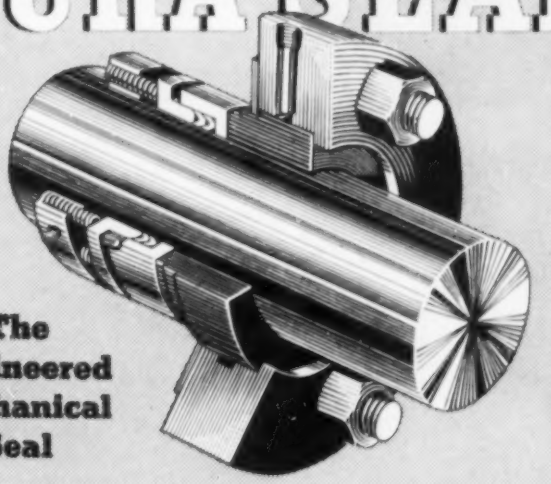
Circle No. **22** *on Reply Card*

Fire-Resistant Lubricant

. . . **reduces carbon deposition on** exhaust valves and piping for air compressor systems.

Trademarked "Pydraul AC," the synthetic lubricant is a fire-resistant fluid equivalent in lubricity to a premium grade oil. It has a pour point of 20°F, a specific gravity of 1.35, and an autogenous ignition tempera-

DURA SEAL



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21st Year

DURA SEALS provide perfect sealing on rotating shafts on processing equipment for the widest range of fluids, pressures, temperatures and speeds.

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KALAMAZOO MICHIGAN

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...for TEMPERATURE RECORDING...

One of the many uses for Auto-Lite Recorders is the application shown below . . . a natural gas field meter run.

Auto-Lite Model "1000" Temperature Recorder has 6" chart. Various standard ranges from minus 40° F to plus 550° F. Available for wall mounting, portable or portable self contained use. Electric or mechanical chart drive. Choice of 24-hr. or 7-day cycle. Capillary tubing permits remote reading. Priced as low as $49.50. Manufactured to customers' specifications. Send for latest Catalog describing many types of Auto-Lite Recorders and Indicators.

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A DARN GOOD WIRE SCREEN

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Look no more—specify **CLEVELAND** Wire Screens for **YOUR** next installation.

Available in all corrosion-resistant metals and alloys, such as:

Stainless Steel
Monel
Nickel
Silver
Copper Alloys

CLEVELAND Wire Screens are designed for longer life and better service.

Woven to individual specifications for every purpose in any size or dimension, such as Vibrating Screen Sections, Filter Segments, Strainer Elements, Centrifuges.

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Filter Segments & Strainer Elements to your individual needs . . . . in all commercial metals and alloys.

Easy to order—send us your requirements.

STRAINERS AND FILTERS

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Custom-built and adapted to individual needs. Available in all commercial metals and alloys.

Write for Bulletin 6, 7, and 8

The CLEVELAND WIRE CLOTH & MFG. Co.
3573 E. 79TH ST.
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ture of 1100°F. It has very little solubility in water.

Although no single explanation exists for the cause of fire and explosions in air compressor systems, it seems that they involve combustible films or mists of petroleum-based lubricants, or their residues. Pydraul AC markedly reduces carbon deposition when in this use. Conversion of compressors from petroleum lubricants to this lubricant is simple. Splash-lubricated compressors need only be cleaned of their petroleum deposits before installing the new fluid. Separate force-feed cylinder lubricators can be converted with modification kits available from major lubricator manufacturers. **Monsanto Chemical Co.**, 1700 S. Second St., St. Louis 4, Mo.

Circle No. **23** *on Reply Card*

Liquid Feeder

. . . **is accurate to** ± ½% regardless of changes in viscosity, specific gravity or temperature.

Feeding mechanisms may be varied to suit the job, and include various types of control valves (diagram shows pneumatic operated valve) gear pumps, and other positive-displacement pumps. The feeders operate on a loss-in-weight principle and are adaptable for either discharge into pressure or vacuum conditions. Control may be either electronic or pneumatic. Incorporated is a memory device which automatically corrects for over- or underfeed. A 100:1 feed range permits adjustment to meet formulation changes. **Omega Machine Co.** (Division of B-I-F Industries, Inc.), 345 Harris Ave., Providence 1, R. I.

Circle No. **24** *on Reply Card*

(Continued on p. 198)

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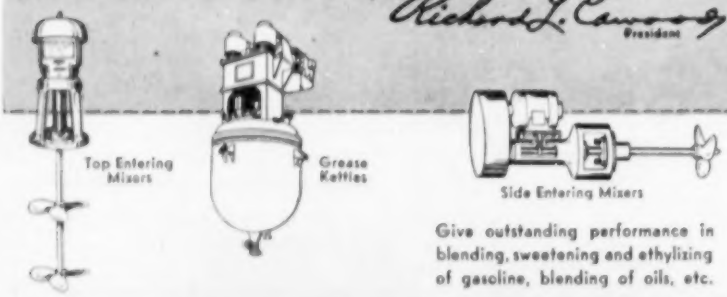
IN TODAY'S GREASE MANUFACTURE

PATTERSON
GREASE MIXERS

Patterson Grease Kettles and Mixers lead the field in heavy lubricant production. Equipped with heavy duty, double motion drive and efficient clean-scraping stirrers. Let us explain the many advantages to you!

Richard L. Cameron
President



Give outstanding performance in blending, sweetening and ethylizing of gasoline, blending of oils, etc.

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LOOKING FOR EXTRA OCTANES?

...they've been found with

AEROCAT® CATALYSTS

A survey of 42 cat crackers showed that those using Aerocat were averaging 2½ octanes higher than comparable units operating with natural catalyst! But extra octanes are only one of the benefits assured by Aerocat. High throughput, low stack loss and excellent stability contribute to the high overall efficiency.

Equally important... behind AEROCAT'S efficiency stands

OPEN-EYED RESEARCH... that keeps making innovations in catalyst design... keeps looking for new ways to solve catalyst problems.

HARD-HEADED QUALITY CONTROL... that insists on "specification *plus*" in every carload that leaves the plant.

FIELD-TRAINED TECHNICAL SERVICE... that knows how to relate specialized knowledge of catalyst production to your cracking problems.

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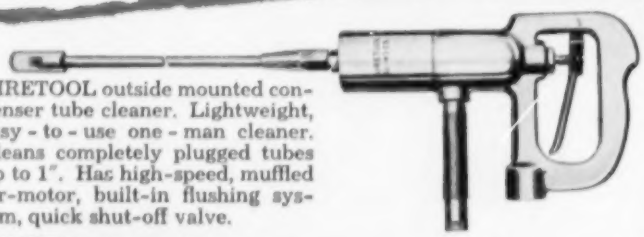
AIRETOOL
makes every type of tube maintenance tool

Look no further than AIRETOOL for dependable, cost-saving tube maintenance equipment. Precision made Airetool tube cutters, cleaners, expanders, accessory and specialty tools meet **every** tube maintenance need. Save time and money on **every** job.

NEW . . . AIRETOOL Internal Tube Cutter. New single-stage, air-driven motor is designed and built by AIRETOOL. Quickly, inexpensively removes damaged or leaky condenser tubes. Optional electric motor for use where air supply is not available.



AIRETOOL outside mounted condenser tube cleaner. Lightweight, easy-to-use one-man cleaner. Cleans completely plugged tubes up to 1". Has high-speed, muffled air-motor, built-in flushing system, quick shut-off valve.

AIRETOOL Automatic Tube Expansion Control . . . automatically, accurately rolls tube joints to proper tightness. Portable unit goes right to job site.

AIRETOOL Tube Removal Tools are great for retubing a bundle. Quickly and efficiently remove tubes and tube stubs from condenser tube sheets.

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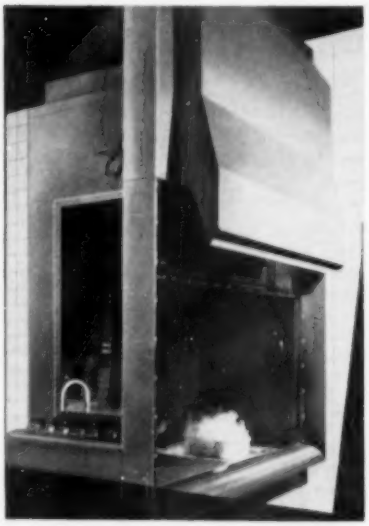
Write for illustrated literature on condenser tube maintenance tools.
Ask for Bulletin #59.



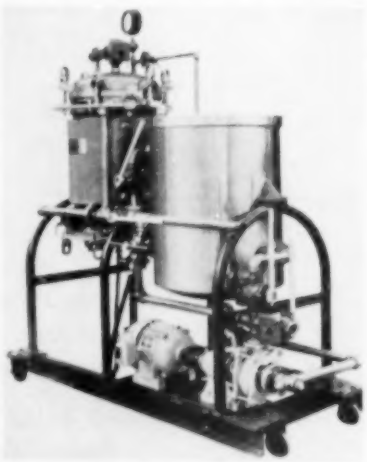
Fume Hood

. . . **provides turbulence-free atmosphere** for controlled experiments, and reduces conditioned-air loss by 50%.

Constructed of epon phenolic-coated sheet metal, the hood is resistant to acid or alkali fumes. It has separate supply and exhaust plenums which deliver outside air and remove inside fumes.

The unit provides a safe experimental working area with a 3- x 4-ft reinforced safety glass door, counterbalanced for easy accessibility. Fluorescent lighting illuminates the inside of the work space. **Kirk & Blum Co.**, Cincinnati 9, Ohio.

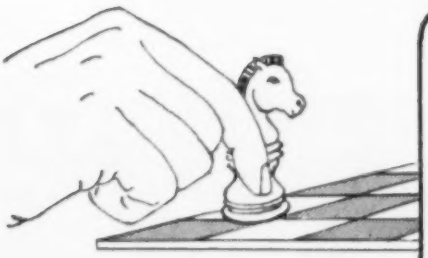
Circle No. **25** *on Reply Card*



Portable Filtration Station

. . . of stainless steel can be used for pilot plant or other small batch operations.

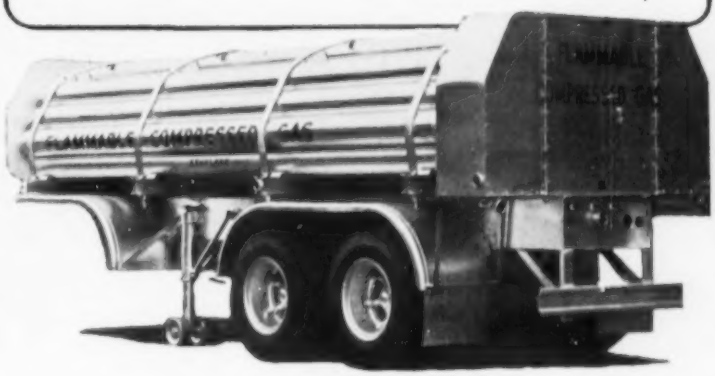
The complete unit includes a ver-



GAS STORAGE is your move with TAYLOR-WHARTON GAS TRANSPORTS

TAYLOR-WHARTON Gas Transports provide mobility of gas storage for users of bulk compressed gases. Economy and flexibility of operations make these transports preferable to permanent bulk storage for many oil refining, petrochemical, food and electronic companies, especially where interplant haulage and standby needs are important.

Each transport contains a group of seamless steel storage pressure tubes made to ICC-3A2400 specifications. Rigidly mounted to a standard semi-trailer chassis, the tubes are valved and manifolded together to a common outlet in a rear-mounted weatherproof cabinet. Standard capacities from 38,500 cu. ft. to 56,250 cu. ft. Other sizes as required.



Send for further information, mentioning type of gas and storage requirements

TAYLOR-WHARTON CO.
Division of HARSCO CORPORATION

Harrisburg 23, Pennsylvania

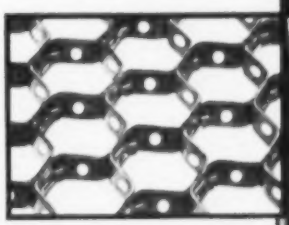
Prolong the life of vessel liners and decrease frequency of costly shutdowns with . . .

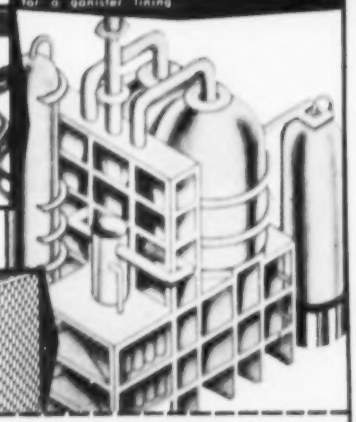
KLEMP HEXTEEL

• *Retard Abrasive and Corrosive Action!*

HEXTEEL is a steel armor and retainer for castable refractory monolithic linings used for cat crackers, reactors, regenerators, fractionators, heaters, strippers, risers, stacks, cyclones, ducts, breeching, furnaces and tanks . . . .

Applying refractory material to the Hexteel for a ganister lining





1. Outside shell
2. Stud
3. Insulating material
4. Refractory material retained in place by Hexteel.

HEXTEEL prolongs the life of an installation by retarding abrasive and corrosive action! Our engineering department is prepared to design your total lining requirements. Fabricated in carbon or stainless steel. . . . .

KLEMP METAL GRATING CORPORATION
6645 South Melvina Avenue — Chicago 38, Illinois
POrtsmouth 7-6760

Gentlemen:
Kindly send me a FREE copy of "Serving the Oil Industry for Over 40 Years".

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Firm_____
Position_____
Address_____
City_____ Zone____ State_____
Phone_____

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LITHIUM HYDRIDE
LITHIUM HYDROXIDE
LITHIUM CARBONATE
LITHIUM CHLORIDE—BRINE—ETC.

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MAYWOOD CHEMICAL WORKS
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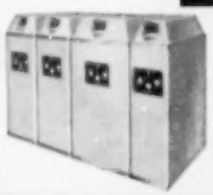
ESTABLISHED 1895

BOWSER

SYSTEMS SPEED PROCESSING TO CUT PRODUCT COST

METERS FILTERS

Metering and filtering of liquids from bulk receipts through delivery assure quantity and quality control.



BLENDERS DEHYDRATORS

Closed system proportioning and blending of liquid stocks plus continuous dewatering where needed, deliver a better end-product at lower cost.

Write for Catalogs

All equipment available on lease or purchase payment program . . .

PROGRESSIVE PROCUREMENT PLAN

BOWSER NATIONWIDE SALES AND SERVICE

REGIONAL OFFICES: ATLANTA · BOSTON · CHICAGO · CLEVELAND · DALLAS · KANSAS CITY · LOS ANGELES · NEW YORK

BOWSER, INC., 1329 E. Creighton, Fort Wayne, Ind.

tical leaf pressure filter with 21.2 sq ft of leaf area, a precoat and slurry tank, pump, valves and piping. All equipment is mounted on a portable frame.

The filter shell is steam jacketed, and the entire unit is made of Type 316 stainless steel or Durimet 20 stainless steel. Valves are Durco Type F with Teflon sleeves; and pump is a series R Durco-pump. The filter is an Enzinger Model DS 18/21.2, with either wet or dry cake discharge of the filter cake. **The Duriron Co.,** Inc., Dayton 1, Ohio.

Circle No. **26** *on Reply Card*

Free Trade Literature

Controlling Combustion

. . . through automatic sensing and controlling instruments: *Control Fundamentals . . . Their Application to Combustion* is a publication reviewing the basic concepts involved in automatic control of boiler combustion. Key components of combustion control systems are described, with a full explanation of their interrelationship in operation of the complete system. Cleveland Fuel Equipment Co., Department A, 1111 Brookpark Road, Cleveland 9, Ohio.

Circle No. **27** *on Reply Card*

Rotational Viscometer

. . . and its wide applications for laboratory or industrial use: *Synchrolectric Viscometer* is a brochure giving complete information on the various models of this instrument which are available, as well as general information on the subject of viscosity. Brookfield Engineering Laboratories, Inc., Stoughton, Mass.

Circle No. **28** *on Reply Card*

Super Pressure Tubing

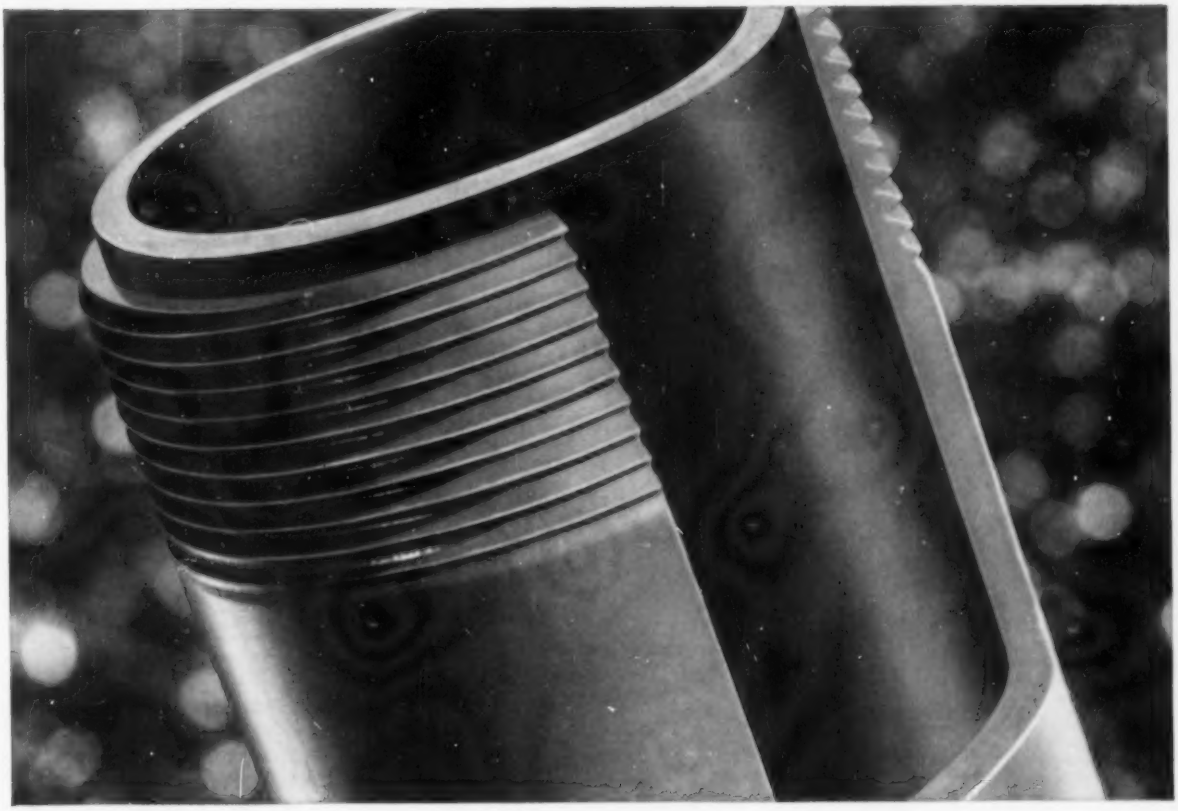
. . . designed for pressures up to 100,000 psi is described in *Data Memorandum No. 22.* This tubing, which is made either as a heavy single or as a composite wall tubing, is available in ten standard sizes from ⅛- to ¾-in. outer diameters. Listed in tabular form are the maximum wall thicknesses for each size and the minimum bursting pressures. Superior Tube Co., Norristown, Pa.

Circle No. **29** *on Reply Card*

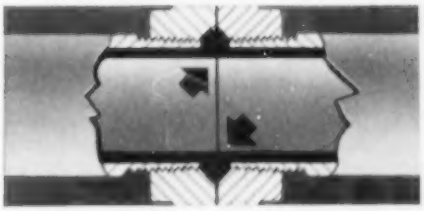
Insulation Problems

. . . in petroleum and petrochemical plants: a set of six case study reports illustrating how actual insulation

DOW



You can see why Saran Lined Pipe prevents corrosion



Liquid never touches metal in Saran Lined Pipe even at a flanged connection like this.

Acids, alkalis and other corrosive liquids never touch the rigid steel pipe . . . it's continuously lined with durable, corrosion-resistant saran

Say good-by to corrosion problems when you install saran lined pipe, fittings, and valves. This combination of corrosion-resistant saran swaged into rigid, non-bursting steel has a proved record of corrosion prevention in the chemical, petroleum, waste, pulp and paper, metal finishing and food processing field.

Saran lined pipe, fittings and valves form tight, snug, leakproof joints . . . is available for working pressures up to 150 psi. Fittings and valves are also available in steel for working pressures to 300 psi. You'll be amazed how easy and economical it is to install this modern piping, too. For it can be cut and threaded in the field with available pipe fitters' tools. And because it's rigid, a minimum of supporting structures are needed.

For further information on saran lined pipe, fittings, and valves send in the coupon on the right today. THE DOW CHEMICAL COMPANY, Midland, Michigan.

Saran Lined Pipe Company
2415 Burdette Avenue
Ferndale, Michigan
Dept. SP626F-1

Please send me information on saran lined pipe, valves, and fittings.

Name _____ Title _____

Company _____

Address _____

City _____ State _____

Saran Lined Pipe is Manufactured by The Dow Chemical Company, Midland, Michigan

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DOW

reodorize petroleum malodors

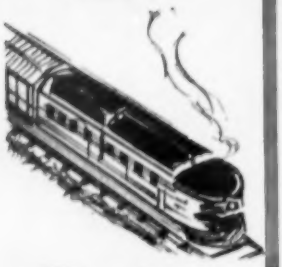
with *Alamask!*

Make olfactorily acceptable petroleum products!

Producers of petroleum products and of petro-chemicals – by adding a selected ALAMASK reodorant – can improve odor characteristics of such materials. A specific ALAMASK is available to achieve adequate reodorization of a variety of petroleum products.

FOR REODORIZATION OF:

FUEL OILS *(regular or premium gasoline blends)*
KEROSENE
DIESEL OILS
CUTTING OILS and SPECIALTIES
many other petroleum products



Gain olfactory relief with an ALAMASK.

Write, wire or phone for specific information. Our Engineering Section provides complete technical guidance.

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A quick solution to this problem can be obtained through an employment advertisement in our CLASSIFIED advertising section.

Petroleum Processing serves the refining and petrochemical industries and is the number 1 publication in readership, circulation, editorial service and advertising value.

Your employment advertisement will be read by just the type of men you need . . . Waste circulation is avoided.

Classified Advertising Division

PETROLEUM PROCESSING

330 West 42nd Street **New York 36, New York**

problems in these industries were solved. The collection of six reports is illustrated with photographs and detail drawings explaining installation procedures and details of each case. Pittsburgh Corning Corp., One Gateway Center, Pittsburgh 22, Pa.

Circle No. **30** *on Reply Card*

General Catalog

. . . of instruments for analysis, control and data processing: *Bulletin 1305* is a 32-page description of the many different instruments available from this manufacturer. Included are recording oscillographs, pressure measuring equipment, digital data processing systems, mass spectrometers, process refractometers and gas analyzers. Consolidated Electrodynamics Corp., 300 North Sierra Madre Villa, Pasadena, Calif.

Circle No. **31** *on Reply Card*

Gas Dehydration

. . . by a new method which triples the efficiency of calcium chloride as a desiccant: *Engineering Report on A New Method of Well-Head Gas Dehydration* is a detailed description of a dehydrator tower which uses the brine formed by the absorbed water to help separate the water vapor from the gas. Fish Engineering Corp., P. O. Box 2617, M & M Building, Houston, Texas.

Circle No. **32** *on Reply Card*

Butterfly Valve Manual

. . . is designed to help engineers select the proper type of this kind of valve: *Bulletin B-2* covers in its 40 pages the many characteristics and physical differences of various butterfly valves. Also included are pressure drop and flow tables, conversion tables, theory and application information. The Henry Pratt Co., 2222 S. Halsted St., Chicago 8, Ill.

Circle No. **33** *on Reply Card*

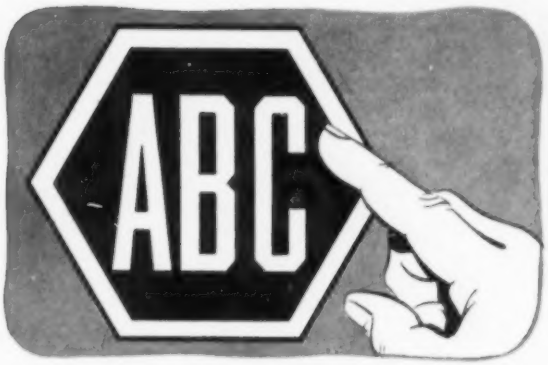
Rust Prevention

. . . by the use of petroleum-type coatings: *The Key to Rust Prevention* is a booklet containing general information on rust preventive compounds and their applications, specifically Valvoline Tectyl coatings. Described are methods of cleaning the material to be coated, a description of the many types of rust preventives which are available, and how to choose the right one for a specific purpose. Included are five comparison charts on Valvoline Rust Preven-

The Reader Is Boss

or... How ABC Helps You Run The Magazine Business

Readers who pay for magazines are always ripe for new ideas, new information, new trends and new technological developments. By giving or withholding their subscription money, reader-customers vote for or against editors and publishers. Counting these "votes" is the important job of the *Audit Bureau of Circulations* – the watchdog of the publishing industry.



YOU CAN TELL which magazines have fully-audited paid circulation when you see the ABC symbol on their cover or contents page. This is the symbol that stands for the Audit Bureau of Circulations, a cooperative organization that sets standards of good business conduct for its publisher members.

ACCURATE FIGURES – ABOUT YOU are the heart of ABC's job. ABC does a candid, unbiased, certified audit of all subscription figures of member magazines – and of the subscribers' jobs, functions, and locations. These audits help editors to tailor the contents of their magazine to your specific job interests.

YOU'RE THE BOSS when you pay money for any magazine. Your vote of confidence and your renewals of subscriptions are dominant in the thinking of editors and publishers. Advertisers are vitally interested, too, and their support helps earn the dollars needed to do a stronger, more useful editorial job for you.

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McGRAW-HILL MAGAZINES

McGRAW-HILL PUBLISHING COMPANY, INC.

330 WEST 42nd STREET, NEW YORK 36, N. Y.

Put yourself in this picture . . . You're getting "down-to-earth" facts on how you can save money through more efficient sealing methods.

How? A "John Crane" trained field engineer is making a complete survey of your pumps, valves and any other equipment where sealing is required —and is carefully analyzing your needs. He's an expert. You could see that as soon as he went to work.

This service is being given without obligation. The "John Crane" man has even suggested a few trial installations to prove the effectiveness of his recommendations. In the end, you'll be well ahead with sealing methods substantially better than those you are now using.

Get action now! Fill out the card below and a "John Crane" field representative will be at your service. Remember—no obligation!

CRANE PACKING COMPANY
6432 Oakton Street, Morton Grove, Illinois (Chicago Suburb)

We would like to discuss our sealing problems with your field engineer. At present our interest is in

☐ A PLANT SURVEY
☐ A FEW TRIAL INSTALLATIONS

Company Name_____

Address_____

_____

Date_____ Signed_____

CRANE PACKING COMPANY

tives, which present detailed application data. Tectyl Division, Valvoline Oil Co., Freedom, Pa.

Circle No. **34** *on Reply Card*

Power Pipe Pushing

. . . is a method of installing either rigid pipe or flexible conduit underground without costly digging: this 16-page book of operating instructions for an hydraulic pushing device describes how to install pipe sized ¾- to 8-in. diameter in underground installations. Mercury Hydraulics, Inc., 2440 Blake St., Denver 5, Colo.

Circle No. **35** *on Reply Card*

Model Components

. . . for the do-it-yourself designer: *Modern Engineering Tools* is a 26-page catalog of valves, pipe fittings, pumps and motors, vessel saddles, structural shapes and other model parts needed for designing process facilities via the model route. Prices for the parts are included in the catalog. Engineering Model Associates, Box No. 22020, Los Angeles 27, Calif.

Circle No. **36** *on Reply Card*

Mechanical Packing

. . . of many types is described in *Catalog No. 56.* Featured in the 24-page catalog are recently developed Bel-Vee V-Ring packings, criss-cross braid packing, twisted foil packings for oil and distillate temperatures to 1000°F, plus a new Inconel-wire reinforced plastic packing for valves handling superheated steam at temperatures up to 800°F. Belmont Packing & Rubber Co., Butler and Sepviva Streets, Philadelphia, Pa.

Circle No. **37** *on Reply Card*

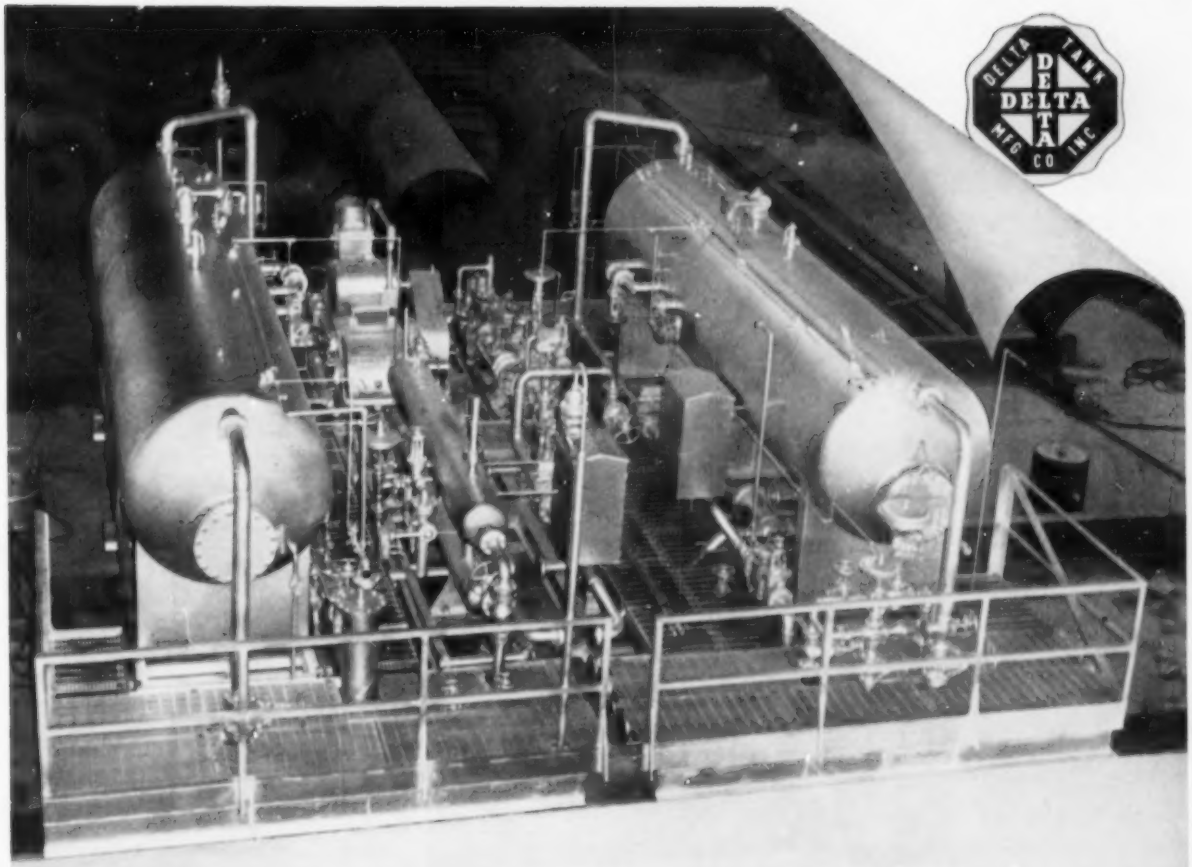
All-Electronic Controls

. . . now employ printed circuits, miniature tubes and plug-in panels for unitized control: *Bulletin A-800* describes the physical contruction of the "Autronic" unit instruments that can be replaced without re-wiring. The only external connections for a system of these recorder and controller units are made at a terminal strip at the rear of the mounting case. The Swartwout Co., 18511 Euclid Ave., Cleveland 12, Ohio.

Circle No. **38** *on Reply Card*

Hydraulic Fan Drives

. . . for air-cooled heat exchangers and cooling towers: *Bulletin 3009* includes detailed information on the



You should see what's inside!

This complete package production unit recently delivered to a customer in the Gulf area by Delta Tank, is another example of the engineering skill and fabrication experience available at Delta.

Delta's modern facilities are geared to produce the type of pressure equipment needed by the Petroleum, Petro-chemical and Chemical industries. Delta's Baton Rouge plant is located right in the heart of the great new Gulf Petroleum area.

Complete information on Delta's facilities, or your specific equipment needs, is available at your request.

DELTA TANK MANUFACTURING CO., INC.

BATON ROUGE, LA. • NEW YORK, N. Y. • LAFAYETTE, LA. • WESTWEGO, LA.
BOSSIER CITY, LA. • HOUSTON, TEXAS • WHITTIER, CALIF.

Pioneers in the remote gauging field, "Varec" has researched the various possible types of remote gauging, and developed a system that offers an unusual combination of advantages for the user. "Varec" PULSE CODE uses a distinct code combination of dots and dashes for each signal to insure accurate reading; the possibility of error resulting from a miscount of pulses, as in a "pulse-count" system is avoided. If the communications channel is capable of carrying any other type of information accurately, it will handle Pulse Code signals without error, or else give no signal. Reliable readings to the nearest 1/8 inch. The system can be operated over all types of communication channels, including micro-wave.

You dial for desired information, then through the use of interlock circuits, the instrument takes over, **to give you a fast reading in 5 seconds.**

Power failure or line trouble will not cause loss of calibration. Normal operation will return on restoration of power. The equipment is rugged and reliable. Vacuum tubes are not used in the measuring circuit.

Great flexibility is assured by the "building-block" design. Special installations can be constructed with standard units – unlimited variations possible. Can provide, with appropriate equipment, a means for remote control of pumps, valves, high-low alarms and similar operating equipment.

Send for the Free "Varec" Bulletin CP-3011

961-16

THE VAPOR RECOVERY SYSTEMS COMPANY

"Varec" Compton, California, U. S. A.

Cable Address: Varec Compton Calif (U.S.A.) All Codes

hydraulic motors, pumps, and worm gear reducers that make up the fan-drive unit. Also included in this bulletin are performance curves useful in selecting the right unit for a specific application. De Laval Steam Turbine Co., Trenton, N. J.

Circle No. **39** *on Reply Card*

Gas Analysis

. . . by thermal conductivity: *Folder ND46-91(6)* presents a basic description of the direct thermal conductivity method for determining concentration of gases. It is applicable in measuring and/or controlling CO_2, SO_2, H_2, NH_3, Cl_2, and O_2 content of process gases. Typical applications are described, and specifications of the control systems are listed. Leeds & Northrup Co., 4907 Stenton Ave., Philadelphia 44, Pa.

Circle No. **40** *on Reply Card*

Steel Buildings

. . . fabricated to specific requirements: *Form No. 56-1-109* catalogs the many types of quickly built rigid frame steel structures. Two basic types are available, each walled with a new zinc-coated steel panel which is locked to the steel frame with neoprene gasketed self-tapping screws. The rigid frame buildings are available in widths of 32, 40, 50, 60, 70, and 80 ft, or multiples of these widths; bays are 20 ft long. The bow string truss structures are either 50 or 60 ft wide, in 16 ft bays. Stran-Steel Corporation, Detroit 29, Mich.

Circle No. **41** *on Reply Card*

Accident Rates

. . . for various industries in 1955 are compiled in a booklet titled "Accident Rates." Included in the 50 pages of tabular matter is a breakdown of frequency rates and severity rates for 40 separate major industries, a listing of no-injury records, definitions of terms used in rating injuries, and historical records of injuries by industries. This past year (1955) the petroleum industry ranked 25th in frequency and 27th in severity rate. National Safety Council, 425 No. Michigan Ave., Chicago 11, Ill.

Circle No. **42** *on Reply Card*

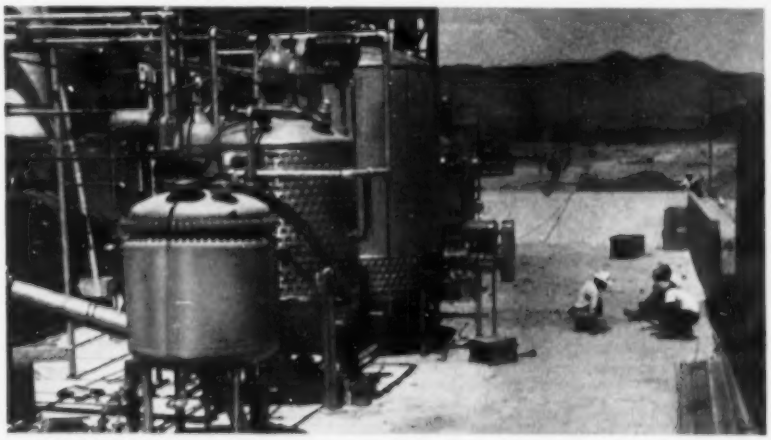
Paint Manual

. . . outlines the many uses for Tygon protective coatings, which are special blends of chemically inert plastic resins formulated with plasticizers and stabilizers. These mate-

Corrosioneering News

Quick facts about the services and equipment available to help you reduce corrosion and processing costs.

Published by The Pfaudler Co., Rochester, N.Y., U.S.A.



THE HEART OF FELVA'S PLANT. Pfaudler equipment lined up here (left to right) consists of a 300-gallon sulfonator, 1000-gallon neutralizer, and a 3000-gallon slurry storage tank. A side-entering mixer keeps the slurry in motion. The pipe-like equipment slanting off to the left of the sulfonator is a Pfaudler heat exchanger. And on the extreme left is a partial view of the stainless cooler. Some of this equipment must withstand the highly corrosive effects of oleum. Pfaudler glassed steel and alloy equipment prove equal to the task.

Pfaudler helps Felva set up new Mexican detergent plant

Productos Quimicos Felva—synthetic detergent manufacturer of Hermosilla—began operations in June. The event culminated a two-year program of planning and building.

To our southern neighbors, the event was especially significant. Felva's plant represents only the second of its type to be owned wholly by Mexicans. To you it most likely represents the kind of contribution corrosioneering makes to the processing industries.

Here's what Pfaudler's project engineers did for Felva: They furnished complete installation instructions including site preparation, general layout, and piping drawings—together with some of the electrical drawings. They furnished specifications for the concrete and suggestions for Felva to use in negotiating plant construction contracts. They furnished on-the-spot aid during the erection and start-up stages. And one of Pfaudler's engineers even prepared design sketches of a water spray cooler, railroad tank car unloading platform, and other appurtenances to the plant — even though these were not the responsibility of *The Pfaudler Co.!*

That's the kind of engineering service you can get from Pfaudler's project engineers. Skilled in the corrosioneering of all types of processing equipment, they're well qualified to help you with *your* processing problems.

To learn more about this unique service, contact your nearest Pfaudler representative, Or write direct for a free copy of the "Buyer's Guide."

Mammoth new dryer-blender speed-dries 165-cu.-ft. batch

Now you can speed-dry larger batches of highly corrosive products than ever before. The enormous working capacity of this giant dryer-blender permits fast drying of up to 165 cubic feet of material.

You get more than just a *dryer* with the Pfaudler unit — you get a

dryer-*blender* that offers these important benefits:

Higher Heat Transfer
Lower Power Requirements
Improved Heat Transfer
Corrosion Resistance
Even Drying *and* Blending

You'll enjoy all these benefits with any Pfaudler conical dryer-blender. Exclusive features of the big new *eight-foot* dryer-blender include 1) lubricated stuffing box, 2) gear-driven unit, 3) 15-hp explosion-proof motor *with magnetic brake*, and 4) pre-formed stand.

Learn more about this unique dryer-blender. Write today for your free copy of Data Sheet 26.

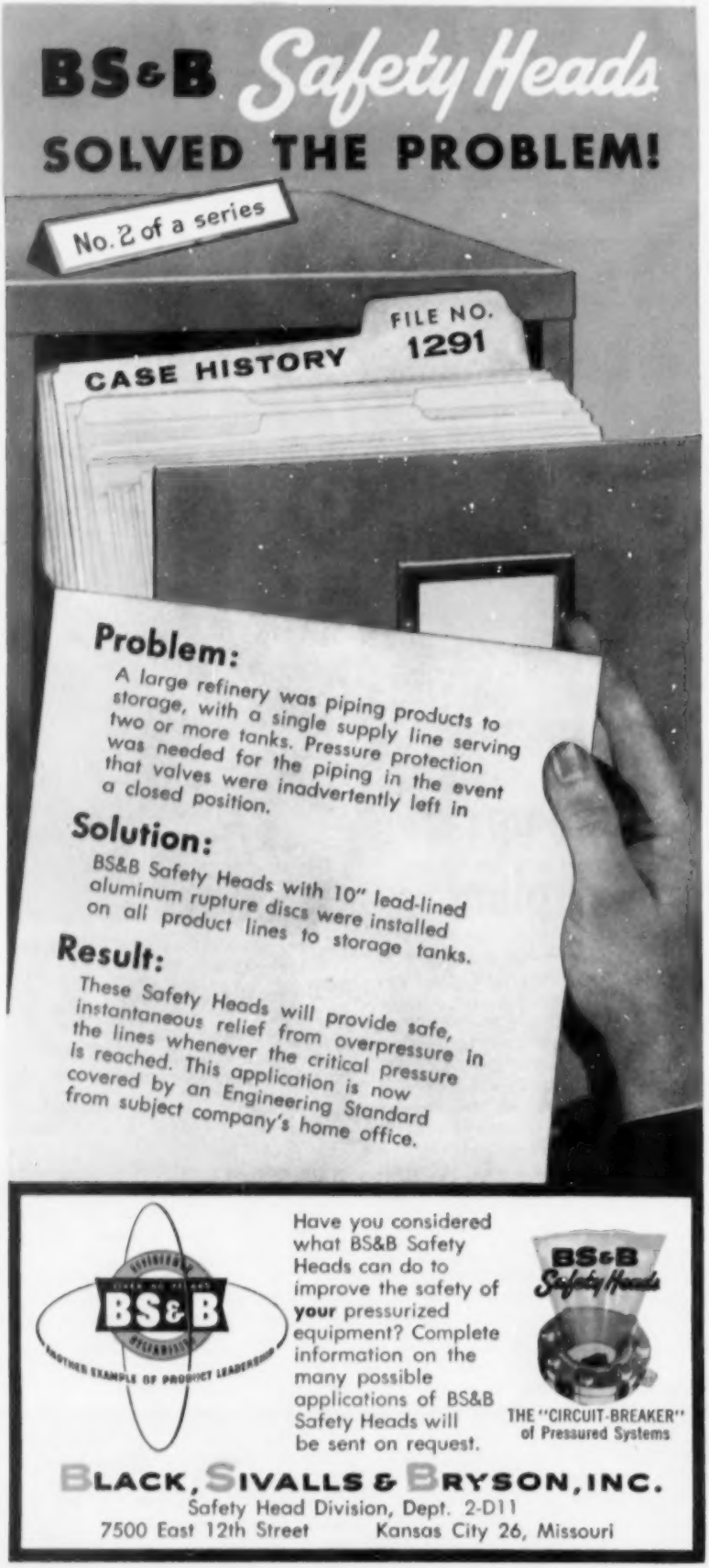
Nickel-clad columns

Here are two nickel-clad columns designed for petrochemical service. The unit on the left is 46 feet long, the other 56 feet.

Pfaudler's experience with both glassed steel *and* alloy columns qualify our engineers as impartial assistants to you in *your* column selection problems. Make doubly sure you order the *right* column by checking with us before you buy.

Send for Bulletin 940.

 (To obtain more data on advertised products see page 182)


BS&B Safety Heads
SOLVED THE PROBLEM!
No. 2 of a series
CASE HISTORY
FILE NO. 1291
Problem:
A large refinery was piping products to storage, with a single supply line serving two or more tanks. Pressure protection was needed for the piping in the event that valves were inadvertently left in a closed position.
Solution:
BS&B Safety Heads with 10" lead-lined aluminum rupture discs were installed on all product lines to storage tanks.
Result:
These Safety Heads will provide safe, instantaneous relief from overpressure in the lines whenever the critical pressure is reached. This application is now covered by an Engineering Standard from subject company's home office.
BS&B
ANOTHER EXAMPLE OF PRODUCT LEADERSHIP
Have you considered what BS&B Safety Heads can do to improve the safety of your pressurized equipment? Complete information on the many possible applications of BS&B Safety Heads will be sent on request.
BS&B Safety Heads
THE "CIRCUIT-BREAKER" of Pressured Systems
BLACK, SIVALLS & BRYSON, INC.
Safety Head Division, Dept. 2-D11
7500 East 12th Street Kansas City 26, Missouri

rials are dissolved in solvent materials that evaporate after the coating is applied. *Bulletin #760* presents useful painting data in the form of charts, tables and illustrations for these materials, which are designed for protection of surfaces from corrosive conditions. Plastics and Synthetics Division, The U. S. Stoneware Co., Akron 9, Ohio.

Circle No. **43** *on Reply Card*

Adsorbents

. . . for platinum catalyst systems can absorb the poisoning elements in a pre-treatment of reforming feed stocks: *Preparation of Petroleum Feeds for Platinum Catalysts* is a technical bulletin describing methods for removing arsenic, tetraethyl lead, alkyl sulfur compounds and nitrogen from reforming feed stocks, thereby preventing catalyst poisoning. Minerals & Chemicals Corp. of America, Menlo Park, N. J.

Circle No. **44** *on Reply Card*

Cracking Catalysts

. . . their structure and behavior are explored in a paper entitled "Exchange of Hydrogen between Isobutane and a Deuterated Cracking Catalyst." This is a report on the complex interrelation between the water sorption and the rate of exchange of the hydrogen atoms of isobutane with silica, alumina, active silica-alumina cracking catalysts and silica-alumina catalysts in which K^+ and Ba^{++} have been incorporated by base exchange. Mellon Institute, 4400 Fifth Ave., Pittsburgh 13, Pa.

Circle No. **45** *on Reply Card*

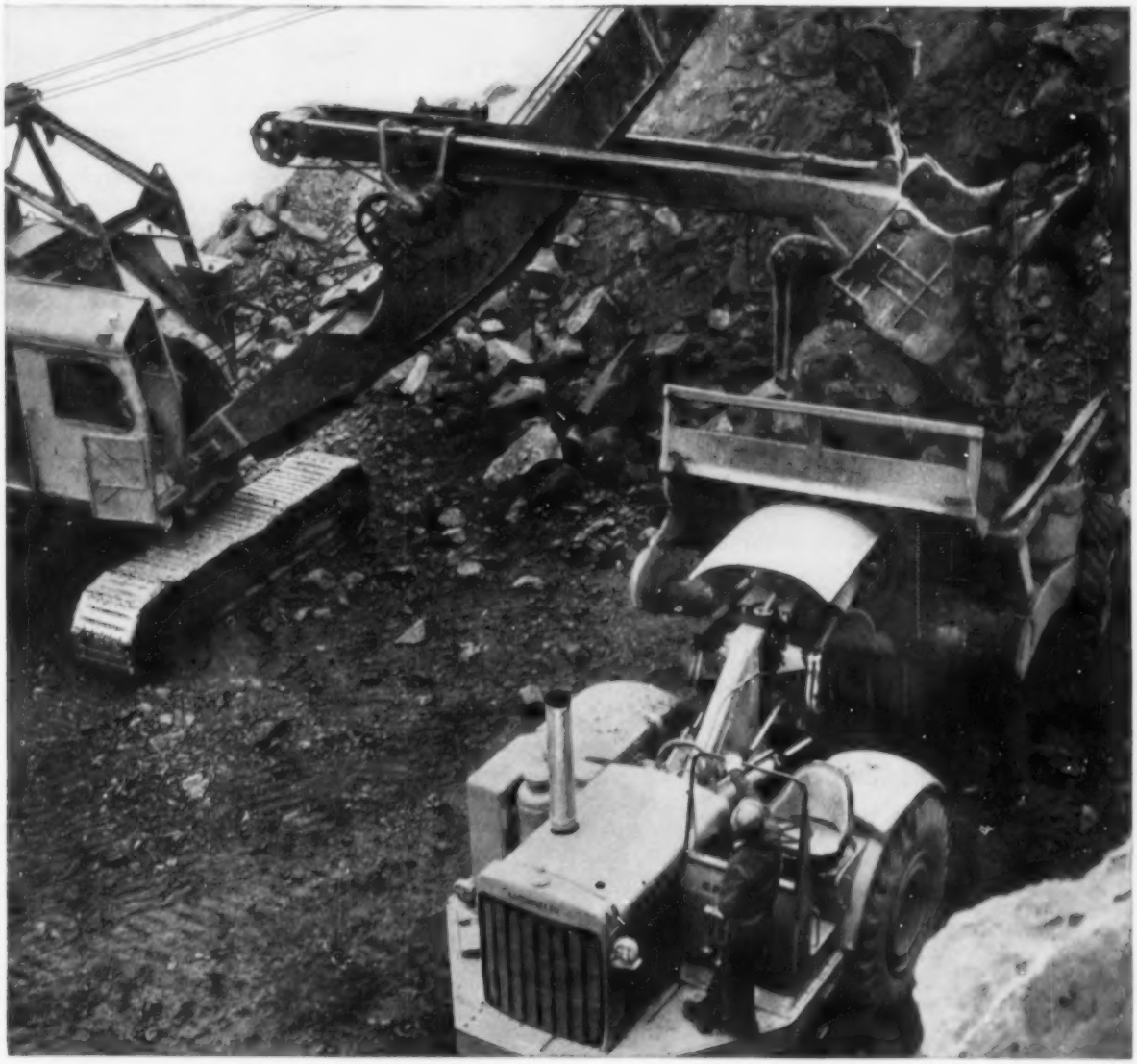
Octane Rating Chart

. . . translates the addition of TEL to isooctane into octane ratings, above the old maximum of 100. Available in either an abbreviated, pocket size plastic card or in a 8½- x 11-in. notebook-size detailed chart, the conversion tables provide a ready reference for converting octane numbers above 100 into ml TEL/ gal of isooctane. They are available by writing directly to Petroleum Chemicals Division, E. I. du Pont de Nemours & Co., Wilmington 98, Del.

Do Not Use Reply Card

Fin-Tube Heat Exchangers

. . . and their heat transfer characteristics are described in *Bulletin FH-3*. Included is a table of dimensions of longitudinal fin tubes, a type desig-



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 (To obtain more data on advertised products see page 182)

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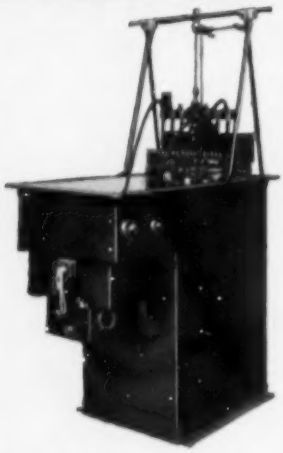
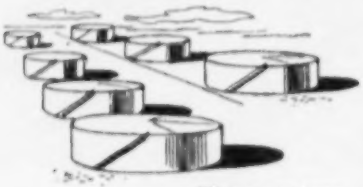
EC&M

TOTALLY OIL IMMERSED 50,000 KVA interrupting capacity MOTOR STARTERS *have many advantages*





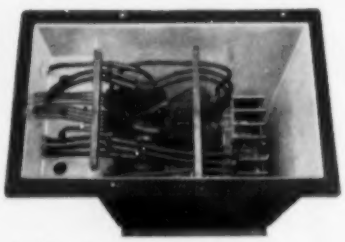
These starters are designed specifically for Division 2, semi-hazardous locations. They are low in first cost and are easy to service when inspection or maintenance are necessary. They require little floor space.

High interrupting capacity is inherent . . . 50,000 KVA and no power fuses required. The well-known Type ZHS Magnetic Contactor has been certified for this rating. It is of heavy-duty construction to assure trouble-free operation.

Before buying 2300-5000 volt motor starters, investigate EC&M Type ZHS Starters. They provide economy in installation, operation and maintenance, and are available in a range of horsepower sizes.

Write for Bulletin 1062-20.

Contactor and Relay Panel are bolted together for raising as a unit above the oil. No leads or bolts to disconnect. Shown is Cat. No. 2645A Lifting Mechanism, available at small cost.



Looking down into starter showing anti-syphon lead construction from contactor, control transformer and overload relay panel to conduit connection box with threaded couplings. Starter with oil disconnect switch shown in views above.

SQUARE D COMPANY
EC&M DIVISION • CLEVELAND 28, OHIO

nation table, and charts for finside coefficients and finside pressure drops. Alco Products, Inc., Schenectady 5, N. Y.

Circle No. **46** *on Reply Card*

Odor Control

. . . of refinery operations: *Odor Control for the Petroleum Industry* is a brochure discussing this method of "eliminating" offensive refinery odors. Listed are the sources of objectionable smells in petroleum processing and some of the specific aromatic chemicals which can be used in their control. Rhodia, Inc., 60 East 56th St., New York 22, N. Y.

Circle No. **47** *on Reply Card*

Did You Miss These?

The following items, originally reviewed in July, have aroused considerable interest among readers. They are repeated here briefly as a service to those who might have missed them the first time they appeared. For details or literature, please use the regular Reply Card in this issue.

Dew Point Story

. . . in non-technical language explains terms such as relative humidity, saturation point, dew point and others. *The Dew Point Story* explains the operation of a typical plant compressed air system and why water vapor plays such an important part in its correct functioning. Available in quantity from Hankinson Corp., 260 Biltmore Bldg., Pittsburgh 16, Pa.

Circle No. **48** *on Reply Card*

Steam Pumps

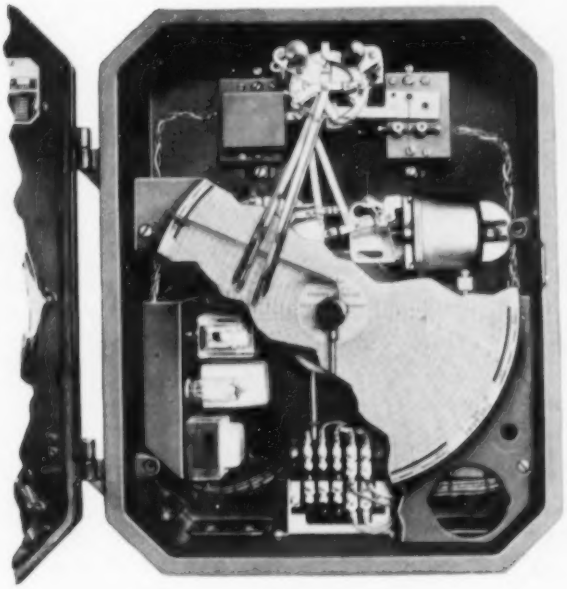
. . . their installation and care: *Booklet G-2280* contains information and photos taken from a sound slide-film used for maintenance instruction courses. A step-by-step series of 88 pictures tells how to increase the service life on all types of steam pumps. Worthington Corp., Harrison, N. J.

Circle No. **49** *on Reply Card*

Thermocouple Data Book

. . . discusses construction and application of thermocouples and radiation detectors for industrial control: *Bulletin F-5228-3* includes information on how to check thermocouples, how to make them and how to select and size them. Included as part of this 40-page booklet are standard thermocouple temperature - millivolts

NEW ELECTRONIC CONTACT CONTROLLER BY *Taylor*



FEATURES

- Changing Resistor-Capacitor Can gives Single Point or Differential Control. Control point easily adjusted by set pointer.
- Fully adjustable, self-locking differential between high and low contacts. Safe contact voltage—never over 6 volts. Current in micro-amps.
- Self-wiping control contacts made of non-corrosive Monel. All other parts are hermetically sealed against corrosion.
- Electronic tube, Relay and R-C Can are plug-in units. Load Contacts on Relay are Single-pole double-throw.
- Attachments can be fitted to present 100 Series Taylor Instruments with no drilling.
- Internal wires and external connections numbered for easy servicing. Signal lights and vibration damping available.

HERE'S rugged, positive contact action for control mechanisms of the two-position action type—the "on-offs", "open-shuts" and "high-lows". This new Taylor Electronic Contact Controller embodies a completely new concept in contact mechanisms—it's designed for:

1. Accurate and dependable operation of electrical circuits.
2. On-off applications with small process lags, slow reaction rates, and small and infrequent load changes.
3. Use on nearly all types of measuring systems—temperature, pressure, liquid level, flow, humidity, speed, etc.
4. Indicating, recording and/or controlling purposes.

An extremely versatile instrument, the new Taylor Electronic Contact Controller can be used in many different places where pneumatic facilities aren't advisable or available. It's made also for use as a supplement to pneumatic control.

These standard forms emphasize the flexibility of the instrument: Two-Position Single Point Action (On-Off), Two Position Differential-Gap Action (On-Off with adjustable differential gap or neutral zone), and Three-Position Differential Gap Action (High-Medium-Low, differential adjustable).

For full details ask your Taylor Field Engineer or write for **Bulletin 98265.** Taylor Instrument Companies, Rochester, N. Y., or Toronto, Canada.

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ACCURACY FIRST
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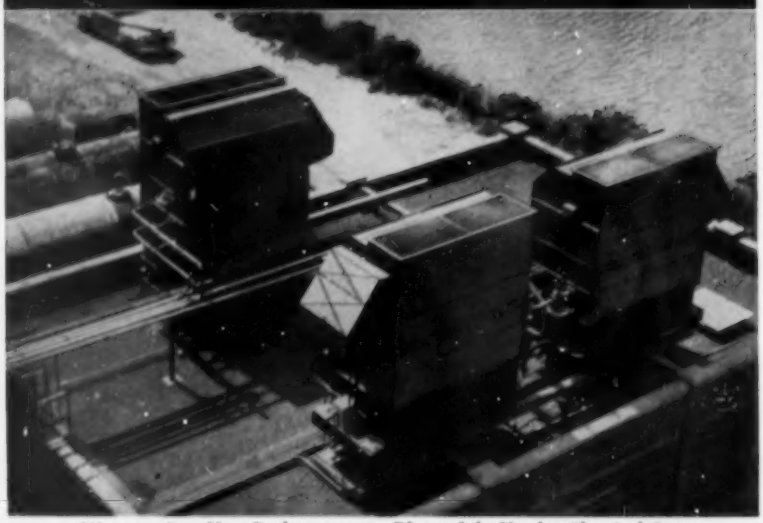
 (To obtain more data on advertised products see page 182)

IMPROVED CONDENSING and Cooling of Reflux



Niagara Aero Heat Exchangers at a Plant of the Heyden Chemical Corp.

Get Better Control of Distillation Product

● Liquid or vapor temperatures are always held constant by the Niagara "Balanced Wet Bulb" control method of evaporatively cooling or condensing, which automatically varies the cooling effect proportionately to the load. The distillation product is therefore uniform throughout all changes in climatic conditions the year around; it is the same in the heat of summer as in the freezing cold of winter. Continuous maximum production is thus insured.

Non-condensibles are effectively separated at the condensate outlet, with notable sub-cooling after separation for greater vacuum pump efficiency.

NIAGARA AERO HEAT EXCHANGERS give sustained full capacity in cooling and condensing with no dependence on cooling water . . . eliminating problems of water supply, availability, temperature, or quality.

For full information write for Bulletin 120

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equivalents, with temperatures expressed on the International Scale of 1948. Electromotive force is expressed in absolute units. Wheelco Instruments Div., Barber-Colman Co., Rockford, Ill.

Circle No. **50** *on Reply Card*

Boiler Feedwater

. . . and its treament by demineralization: *Technical Reprint I-140* discusses in detail the advantages and disadvantages of this process in today's power plants. New developments, trends, and applications of both multi-bed and mixed-bed ion exchange are presented. This 24-page reprint also contains tables on characteristics of anion exchangers, materials of construction, and specific conductivity of effluent. Graver Water Conditioning Co., 216 West 14th St., New York 11, N. Y.

Circle No. **51** *on Reply Card*

Infrared Spectroscopy

. . . a package of reprints on the subject: *Infrared Package* contains a basic introductory article on this analytical tool; a chart summarizing the characteristic infrared absorption bands of specific groups from 4000 to 400 wave numbers; an article on hydrocarbon analysis by spectrophotometric instruments; and a complete index of available reprints on this subject. Scientific Instruments Division, Beckman Instruments, Inc., 2500 Fullerton Road, Fullerton, Calif.

Circle No. **52** *on Reply Card*

Steam-Jet Coolers

. . . in sizes from 30 to 1200 tons of refrigeration: *Form 9143-B* describes how to chill water temperature down to 35° F, using only water and steam, with no toxic refrigerant. Operating pressures are below atmospheric and there are no mechanical moving parts within the machine. An automatic controller for steam flow permits savings on amount of steam used. Ingersoll-Rand, 11 Broadway, New York 4, N. Y.

Circle No. **53** *on Reply Card*

Continuous Analyzer

. . . for binary-liquid streams determines the composition of two-component streams found in distillation, extraction, and washing and filtration. Concentration of both gases and solids in solution can be determined by refraction. The Meeco-Matic Model

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Better Schools, 9 East 40th Street, New York, N. Y.

II differential refractometer is designed for plant operation. It has a sensitivity 10 times higher than many laboratory type refractometers.

The full-scale span of the instrument is adjustable from 10^{-1} to 4 x 10^{-4} refractive index units. The minimum detectable change in refractive index is 1% of full scale at any span. Operating at its highest sensitivity, this instrument can achieve the following full-scale spans:

Mixture	Full Scale, wt %
Acetic acid in H_2O	1.0
Acetone in H_2O	2.0
Ethanol in H_2O	1.5
Methanol in H_2O	20.0
Phenol in H_2O	2.5
Sulfuric acid in H_2O	0.5

The instrument has been developed by the DuPont Co. and is available from Manufacturers Engineering & Equipment Corp., Hatboro, Penn.

Circle No. **54** *on Reply Card*

Sprayable Plastic

. . . permits using ordinary metals in place of costly alloys, when a film of 50 to 60 ml is sprayed in one continuous layer on the metal.

A new formulation permits spraying in one coat "Unichrome Super 5300," a compound based on vinyl resins. It is resistant to strong acids, concentrated caustic and salt solutions, and other corrosive materials. The material forms a tough, flexible film which absorbs impact without chipping and also withstands abrasion. Metal & Thermit Corp., Rahway, N. J.

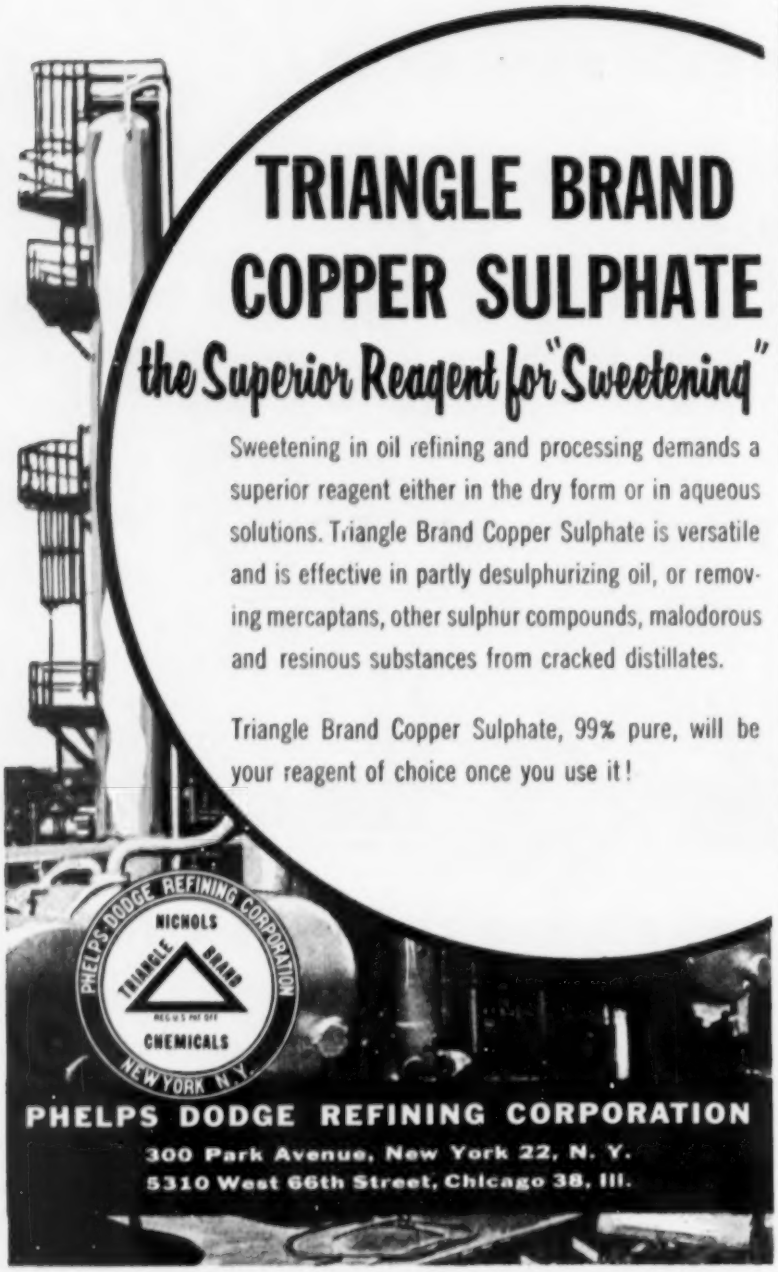
Circle No. **55** *on Reply Card*

Miniature Transducer

. . . changes pressure into voltage that can be read on a voltmeter, observed on an oscilloscope, or fed into a recording system.

Measuring only 1-in. in diameter, this small transducer can be mounted in pressure vessels and pipes without obstructing the flow or causing turbulence. A linear variable differential transformer acts as the sensing device. Absolute pressure ranges are from 0-15 to 0-500 psia; differential pressure ranges from ±0-15 to 0-500 psi; and gage pressure ranges from 0-15 to 0-500 psig. Proper selection of the excitation frequency permits operating the transducer at temperatures up to 450°F. Schaevitz Engineering, P. O. Box 505, Camden 1, N. J.

Circle No. **56** *on Reply Card*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GULF

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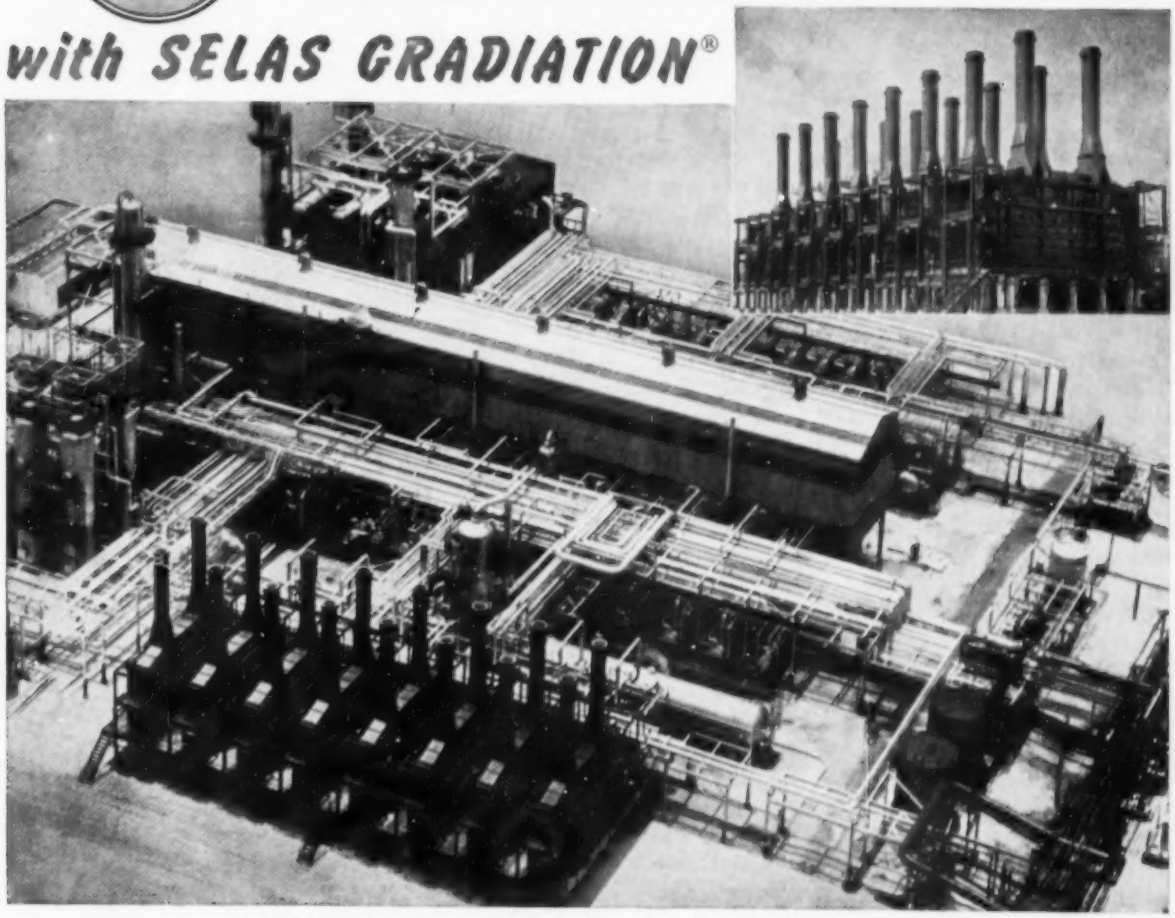


Gulf Oil Corporation's new ethylene plant at Port Arthur, Tex., designed and constructed by Stone & Webster Engineering Corporation. Eight Selas Gradiation heaters are in center foreground.

The world's largest ethylene-producing plant benefits from the versatility of Selas Gradiation heaters. Three separate feed stocks—propane, ethane and propane-propylene mixtures—have been processed interchangeably in all of the eight Selas furnaces.

Operating results on all three feed stocks in the Gulf plant confirm that these Selas heaters provide:

- "On stream" periods, without shutdowns, well in excess of 30 days.
- High conversions and selectivity.
- Optimum conditions, even with extreme variations in feed stock.

Zone control of heat input, enabling Selas heaters to meet any time-temperature curve in pyrolytic or catalytic reactions and high-temperature preheating, is featured by:

- Uniform heat distribution on the entire tube surface which extends tube life by eliminating local overheating and material degradation at the tube wall.
- Controlled combustion, with little or no excess air to cause external oxidation of the tubes . . . no lag in response to controller demand.

Send for copy of reprint, "Try the Gradiation Heater for Economical Ethylene Production" and Bulletin 911, "Gradiation Heating for Petroleum and Chemical Processing."

SELAS *Heat and Fluid Processing Engineers*

CORPORATION OF AMERICA
DRESHER, PENNSYLVANIA

DEVELOPMENT • DESIGN • CONSTRUCTION

The Lone Wolf Is Out-of-Date

LAST MONTH we attended a technical meeting. It wasn't a big one—and it wasn't a major one. But it was an important one—as any such gathering of the technical men in our industry is important. It was important because it provided an opportunity for a group of engineers and plant operators with similar interests to get together, to swap ideas, to know a little more about the rest of the industry.

We were struck, however, by an interesting fact. One major refinery in the area had only two men at that meeting. Another company, by contest, had more then ten times that many there.

When we mentioned the noticeable absence of representatives from that one particular company to a friend of ours with it, he replied: "Our fellows were probably all busy making money."

We don't quarrel with the very admirable aim of making money. As a matter of fact we like to do that very thing ourselves.

We do quarrel with the attitude that the way to make it is to be a lone wolf, to play your cards close to your vest, to erect an "iron curtain" between your men and everyone outside.

Progress isn't made in this country by keeping everything secret. It's made by the interchange of information, by trading what you know for what someone else knows.

An engineer or plant operator learns how his own particular company does things from his daily association with others in that company. But inbreeding is dangerous—both for the individual and the company. Only by association with men from other companies can a man broaden and improve his ability to apply technical principles—for the mutual benefit of himself and his company. Technical meetings are one way to obtain this broader association.

Perhaps the company that keeps its men busy making money would make more money if it didn't work so hard at it.

What's Your Favorite Color

WE HAD a preview recently of "Operation Rainbow"—Gulf Oil Corp.'s plan for transforming its sprawling 600-acre refinery into an industrial Disneyland, bright and colorful.

The plan is to paint every tank, every piece of equipment, every foot of piping in the 183,000 b/d plant in colorful tints of yellows, pinks, blues, grays and greens. It's going to be a complete job. As individual units are shut down for maintenance and overhaul, they'll be scheduled for painting. It is expected to take two and a half years to cover the entire plant.

Care has been taken to select colors that will harmonize with each other. "Two things we didn't want were a circus appearance, or a plant that looked as if someone had walked from one piece of equipment to another dropping buckets of different colored paints," says J. O. Timms, superintendent of Gulf's Philadelphia refinery.

Mr. Timms is the guiding light behind "Operation Rainbow" and is generally given credit for having sold Gulf's top management on the value of the program. He felt that the refinery should be taking an active part in Philadelphia's current program to spruce itself up, that it should become part of the city's "new look." He was strengthened in his belief by the fact that the plant is flanked by two busy highways, used by over 40,000 vehicles a day.

Maybe, as Mr. Timms told us, the desire to be a good citizen was the primary motive behind the decision to paint the entire plant. But he's also quick to point out other more positive values:

1—Losses by evaporation of some of the more volatile materials in storage will be cut to a minimum, because the light-colored, self-cleaning paints have a high heat-reflecting value.

2—More efficient housekeeping will be encouraged, if only because leaks and spills, inevitable in daily plant operations, will be immediately apparent, and cry for attention.

3—Employe morale will be boosted, because of the brighter, more pleasant working environment.

The use of color in plants isn't new. But Gulf claims to be the first to go in for a complete. coordinated job throughout an entire plant—and to plan on getting it done within a relatively short period of time.

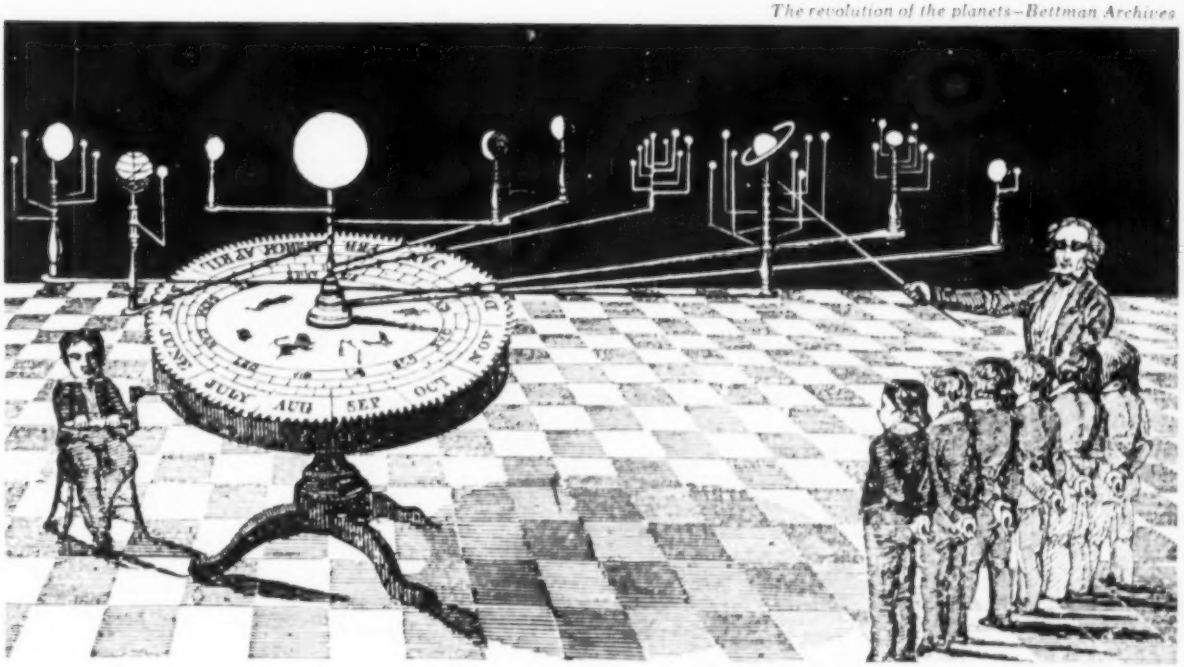
Other companies would do well to keep an eye on what Gulf is doing—and how it pays off. They might find it worth trying.

Smoking—Newest Cause of Smog

CIGARET SMOKING has just been tabbed a smog maker. The Los Angeles Air Pollution Control District estimates that tobacco smoke adds almost 12 tons of contaminants to the air of Los Angeles county every day. It calculates that the nearly 65-million cigarets smoked in the county daily yield 9.267 tons of particulates, plus aldehydes, organic acids, hydrocarbons, and carbon monoxide.

It just doesn't pay to smoke anymore, what with cancer and now smog.

The revolution of the planets—Bettman Archives



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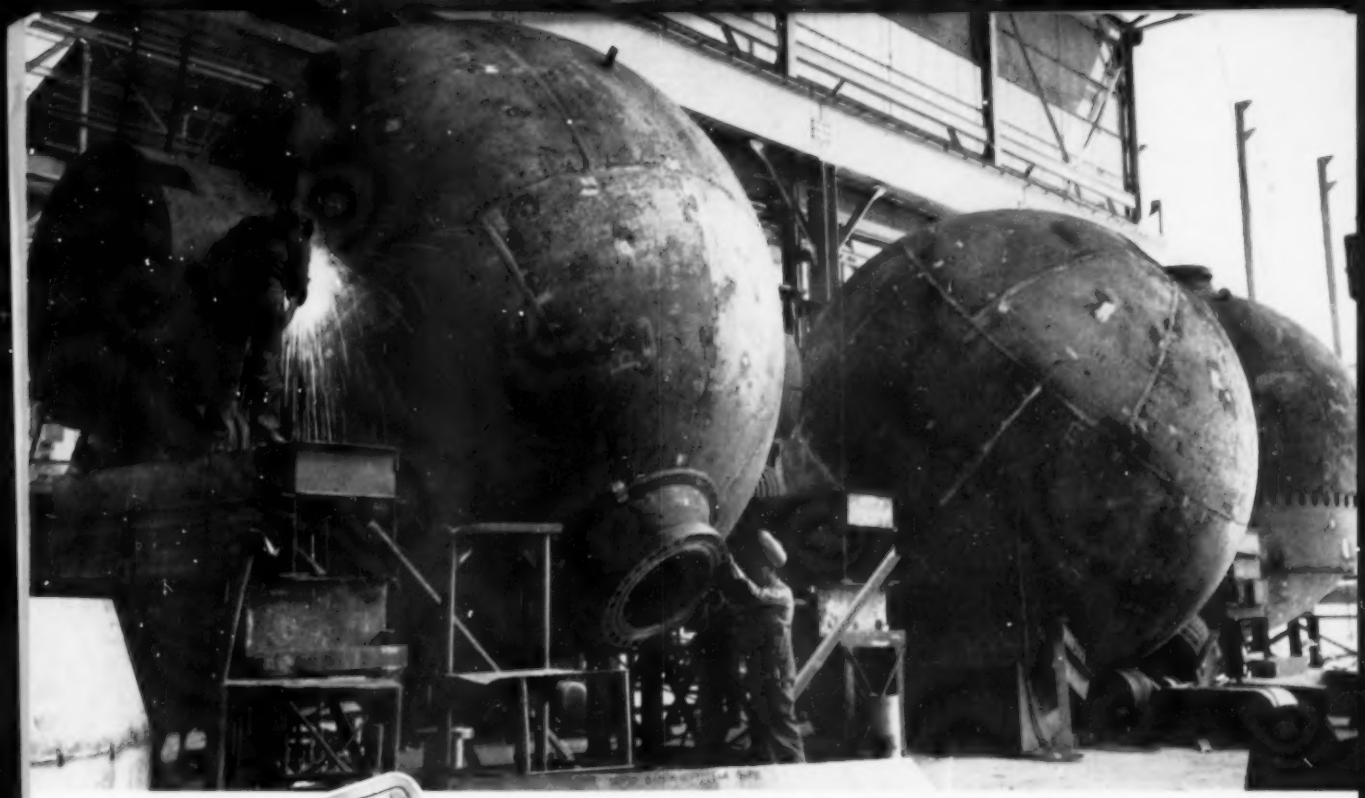

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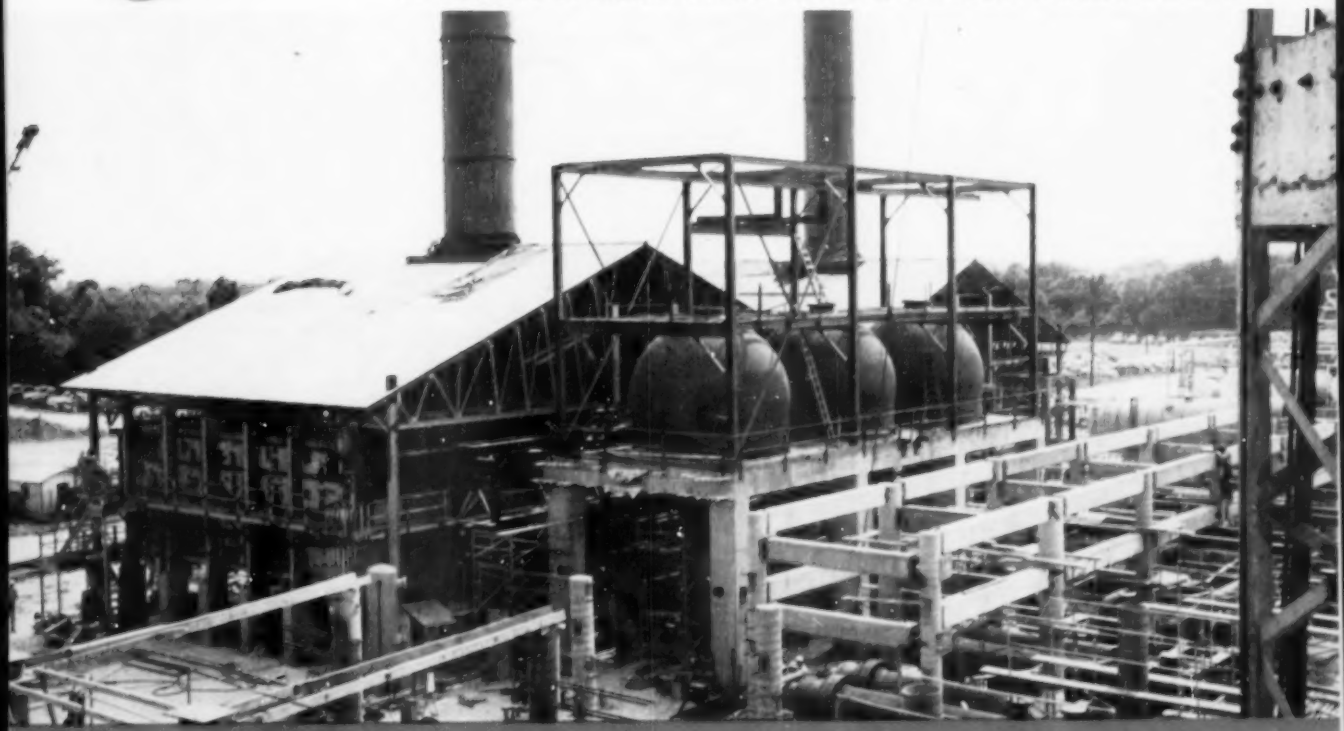
AS INSTALLED BY BECHTEL CORPORATION FOR MAGNOLIA PETROLEUM COMPANY



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